Compressed Air Magazine

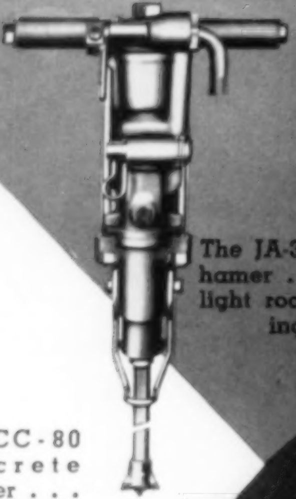
VOLUME 46 · NUMBER 9
SEPTEMBER 1941
LONDON · NEW YORK · PARIS

CLEANING GOVERNMENT RECORDS WITH COMPRESSED AIR

CREDIT: KEYSTONE VIEW COMPANY

DO ALL YOUR JOBS *with* ONE COMPRESSED AIR OUTFIT

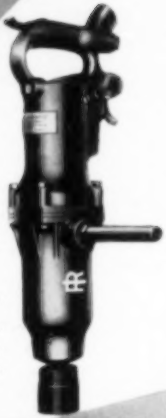
The CC-80 Concrete Breaker . . . an ideal demolition tool.



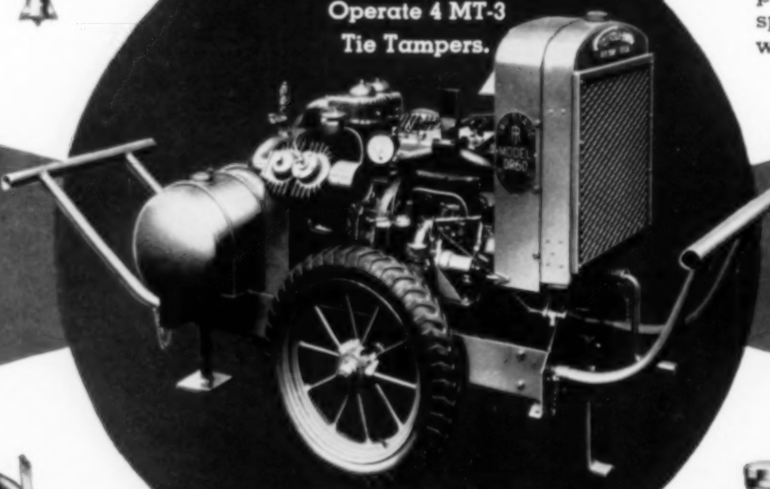
The JA-35 Jackhamer . . . for light rock drilling.

The DR-60 Operate 4 MT-3 Tie Tampers.

The CC-250 will save up to 60% in your spike driving costs.



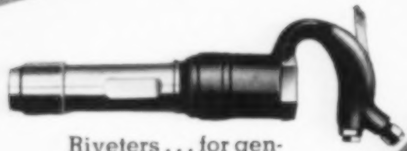
The Size 534 Impact Wrench . . . speeds up bridge work, lag screw driving, etc.



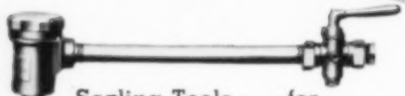
THE DR-60 SPOT TAMPER

Paint sprays for bridges and buildings.

Chipping Hammers . . . many sizes for all classes of chipping, calking, beading, scaling, etc.

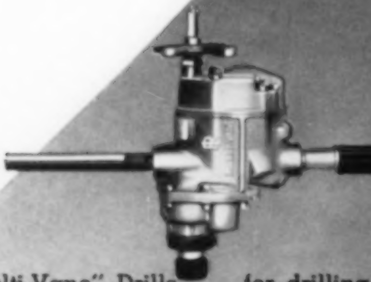


Riveters . . . for general structural and bridge work.

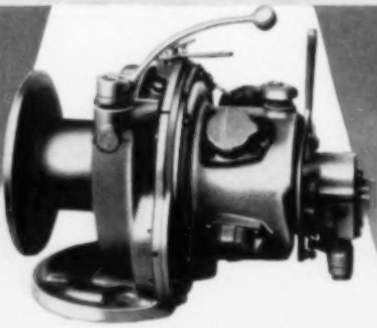


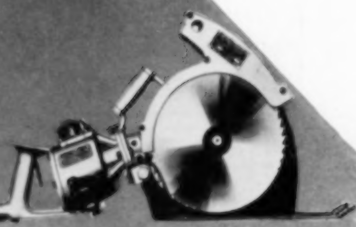
Scaling Tools . . . for cleaning rust, paint, and scale from structural steel.

"Utility" Hoists . . . handy for erection work and all types of lifting up to 3500 lbs. capacity.



"Multi-Vane" Drills . . . for drilling, reaming, and tapping in steel work; for wood-boring.





"Safety-First" Saw . . . does the work of 5 men with hand saws.

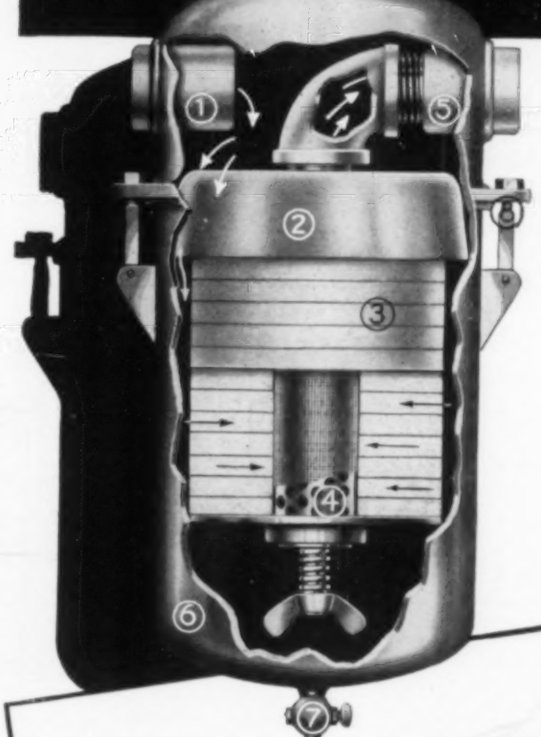
TRACK SUPPLY ASS'N.
EXHIBITOR
ROADMASTERS CONVENTION

Ingersoll-Rand
11 BROADWAY, NEW YORK CITY

11-77

→ SEE OUR BOOTH AT ROADMASTERS' CONVENTION ←

HAZARD of Oil and Moisture in Automatic Controls NOW ELIMINATED



New Filter Delivers Dry Air Only

Amazing results are being reported by users of Staynew's Model AAPHS Pipe Line Filter as a final stage in the protection of delicate pneumatic control instruments.

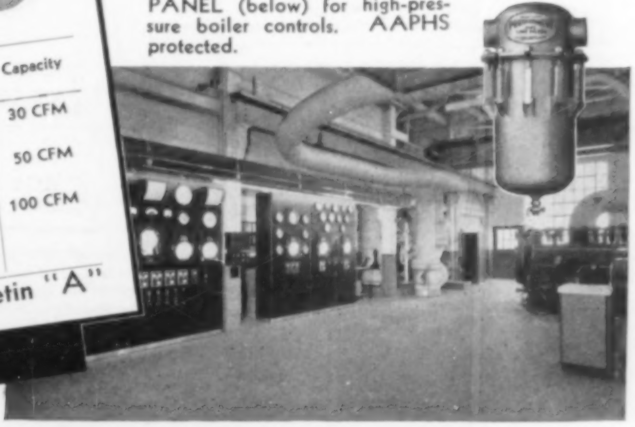
A typical comment is that of a large generator of both electricity and steam who says, "We tried several well-known methods of moisture and oil elimination without satisfactory results. Your Model AAPHS was finally installed in the air line and since then we have had no trouble whatever with oil or moisture in our automatic controls."

NEW 44-PAGE CATALOG: Describes entire line, including filters for building ventilation, pipe lines, engine, and compressor intakes. Your copy is ready.

STAYNEW FILTER CORP.
7 LEIGHTON AVE., ROCHESTER, N. Y.
"Air Filter Headquarters"

PROTECTOMOTOR
99% PerCent
AIR FILTERS

PANEL (below) for high-pressure boiler controls. AAPHS protected.



CONSTRUCTION FEATURES

(1) inlet; (2) baffle that distributes vapor-laden air to sides of container (6); (3) felt rings; (4) perforated liner; (5) outlet; (7) drain cock; (8) swing bolts for easy inspection (optional).

THICK FELT RINGS remove every trace of oil or moisture. ➜

SPECIFICATIONS

Model	Standard Pipe Size	Capacity	Model	Standard Pipe Size	Capacity
AAPH-02 AAPHS-02	¼"	5 CFM	AAPH-2 AAPHS-2	1"	30 CFM
AAPH-01 AAPHS-01	⅜"	7 CFM	AAPH-4 AAPHS-4	1½"	50 CFM
AAPH-0 AAPHS-0	½"	10 CFM	AAPH-5 AAPHS-5	2"	100 CFM
AAPH-1 AAPHS-1	¾"	20 CFM			

Letter S in code Nos. indicates swing-bolt type which facilitates inspection.

Write for Bulletin "A"

HOW THIS LEBANON SYMBOL

CIRCLE Ⓛ

Meets Defense Ⓛ *Specifications*

AT CRITICAL POINTS along America's industrial front line, Lebanon Circle Ⓛ Steel Castings meet the most exacting demands of the emergency. Used directly in military equipment and used in machines that create the sinews of defense, Circle Ⓛ Castings play vital and versatile roles. The table below shows how they meet Federal, S.A.E. and A.S.T.M. specifications.

LEBANON DESIGNATION	GOVERNMENT SPECIFICATIONS	S. A. E. ANALYSIS SPECIFICATIONS	A. S. T. M. SPECIFICATIONS
Ⓛ	QQ—S—681a Class 0	1030	A—27—39 GR.—A—2
Ⓛ	Class 1	1020	A—215—39T GR.—A—2—W
Ⓛ	Class 2	1025	A—27—39 GR.—B
Ⓛ 1	Class 3	X1030	A—148—36 CL.—B GR.—2
Ⓛ 2	Class 4	X4130	A—148—37 CL.—B GR.—3 CL.—C GR.—2
Ⓛ 3	Class 4	4140	A—148—36 CL.—C GR.—3
Ⓛ	Navy Dept. 49S1 J&K Class B	1020	A—215—39T GR.—A—2—W
Ⓛ	Class D	1025	A—27—39 GR.—B
Ⓛ 1	Class A	X1030	A—148—36 CL.—B GR.—2
Ⓛ 1	Class F	X1030	A—148—36 CL.—B GR.—2
Ⓛ	Class C	1025	A—27—39 GR.—N—2
Ⓛ 9	Navy Dept. 46S33		A157—40 GR.—C1
Ⓛ 22 Ⓛ 21 Ⓛ 22 M	Navy Dept. 46S27a Grade I Grade I Weld Grade 7	30905 30705 30615	A157—40 C9a
Ⓛ 1 Mod.	R1XS192	X2030	
Ⓛ HCA #2 Ⓛ HCA #3	Ordnance Dept. U.S. Army AXS492 AXS493 Cast Steel Armor		

All Government specifications are for cast steel.
The Society of Automotive Engineers (S. A. E.) specifications cover rolled steel, but are the approximate corresponding chemical analyses.
The American Society for Testing Materials (A. S. T. M.) specifications are all cast steel specifications.

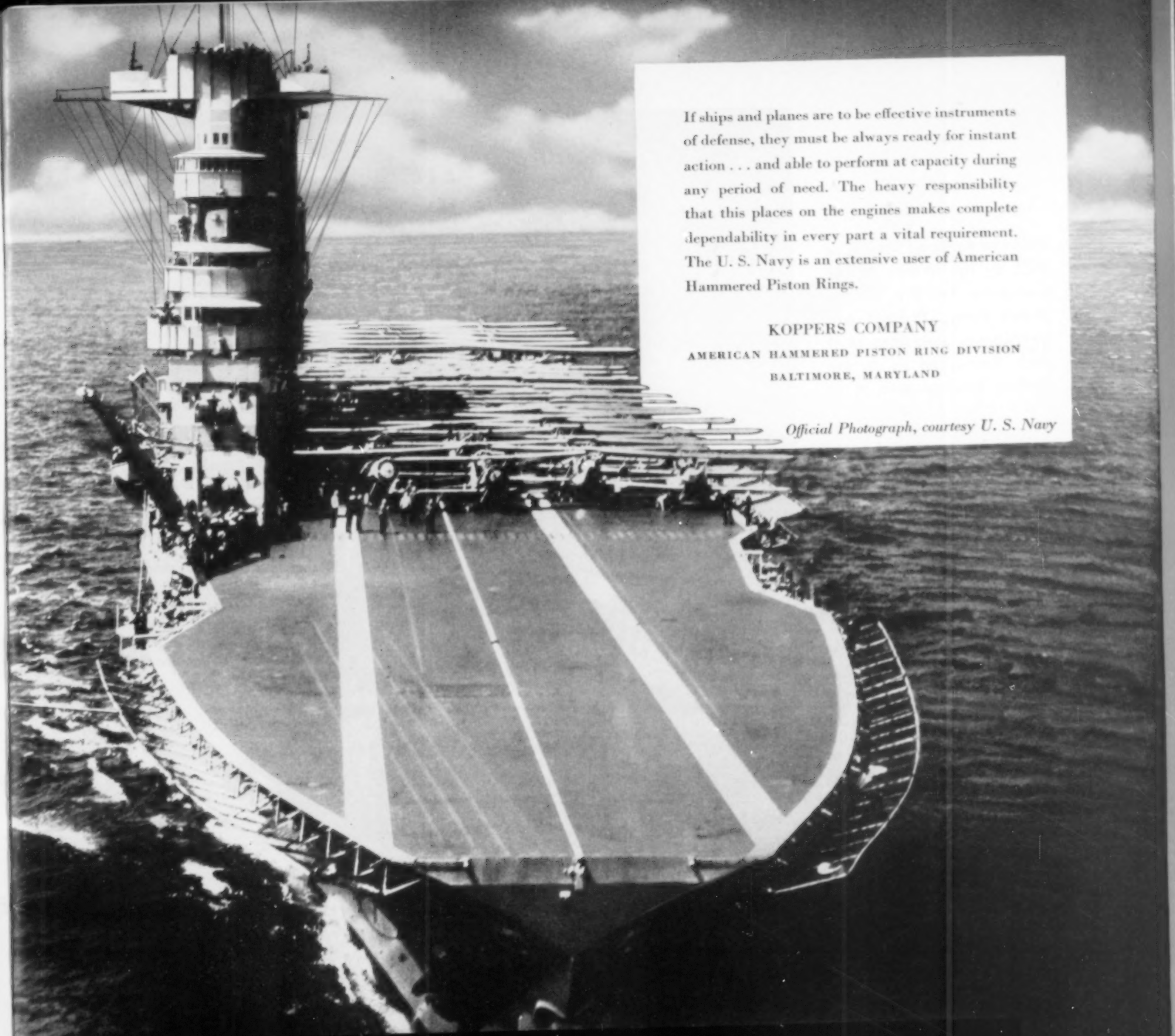
REFERENCE CHART
CIRCLE L
Stainless and Special Alloy Steel Castings

The table shown is from the Lebanon Reference Chart listing comparable classifications of U. S. Government, S. A. E. and A.S.T.M. for Circle Ⓛ Steels. The complete chart . . . which includes analysis and physical properties as well as specifications . . . is available to executives, engineers and metallurgists upon request.

LEBANON STEEL FOUNDRY
511 Lehman St., Lebanon, Pa.

ORIGINAL AMERICAN LICENSEE
GEORGE FISCHER (SWISS CHAMOTTE) METHOD

LEBANON *Stainless and Special Alloy* STEEL CASTINGS



If ships and planes are to be effective instruments of defense, they must be always ready for instant action . . . and able to perform at capacity during any period of need. The heavy responsibility that this places on the engines makes complete dependability in every part a vital requirement. The U. S. Navy is an extensive user of American Hammered Piston Rings.

KOPPERS COMPANY
AMERICAN HAMMERED PISTON RING DIVISION
BALTIMORE, MARYLAND

Official Photograph, courtesy U. S. Navy

American Hammered
Piston Rings

a KOPPERS *product*

KOPPERS
DIESEL PISTON RINGS
KOPPERS
COMPRESSOR PISTON RINGS
ENGINEERS'
PISTON RING
HANDBOOK
AMERICAN HAMMERED
PISTON RINGS
KOPPERS product

MAIL THE COUPON FOR FREE TECHNICAL LITERATURE

KOPPERS COMPANY
7130 Koppers Building, (19) Pittsburgh, Pa.
Please send me the technical literature checked:

☐ "Piston Rings for Diesel Engines"
☐ "Piston Rings for Compressors"
☐ "Piston Ring Handbook"
☐ "How to Order Piston Rings"
☐ "Automotive Piston Ring Set-ups"
☐ "Rings for Miscellaneous Applications"
☐ "Fast's Self-aligning Couplings"
☐ "All-Iron Gate Valves"
☐ "Pressure-treated Timber"
☐ "Prevention of Termite Damage to Buildings"

NAME.. TITLE....................

COMPANY..

ADDRESS..

Half-trac Armored Scout Car built by the White Motor Company for the United States Army. It takes and overcomes conditions as it finds them—and so do the Timken Bearings used in it.

U.S.A.W-4010877

FOR THE TOUGH JOBS OF DEFENSE

Ingersoll-Rand
MOBIL-AIR

MOBIL-AIR Compressor manufactured by Ingersoll-Rand supplies air power for construction projects of all kinds. Equipped with Timken Bearings on the crank shaft and road wheels.

All kinds of machines are needed in the big drive for National Defense—on the fighting line and behind it. Two of the many different pieces of modern equipment are shown here.

Timken Bearings give your machines the same speed, precision and endurance they are giving America's defensive armament—guns, tanks, trucks, armored cars, airplanes and warships.

THE TIMKEN ROLLER BEARING COMPANY, CANTON, OHIO

TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS

Manufacturers of Timken Tapered Roller Bearings for automobiles, motor trucks, railroad cars and locomotives and all kinds of industrial machinery; Timken Alloy Steels and Carbon and Alloy Seamless Tubing; and Timken Rock Bits.

It's Open and Shut!

As final as the "ump's" verdict is this fact . . . the valves in *your* compressors will keep free, open wide and shut tight, when proper lubrication keeps them clean.

In thousands of compressors, clean valves, free rings, and higher all 'round efficiency are direct results of lubricating with TEXACO.

Texaco Alcaid, Algol and Ursa Oils are highly stable, resist gumming, sludging and the formation of carbon deposits. They assure more efficient valve action and much longer service between inspections and cleanings.

The outstanding performance that has made Texaco preferred in the fields listed in the panel has made it preferred also by compressor operators everywhere.

These Texaco users enjoy many benefits that can also be yours. A Texaco Lubrication Engineer will gladly cooperate . . . just phone the nearest of more than 2300 Texaco distributing plants in the 48 States, or write:

The Texas Company, 135 East 42nd Street, New York, N. Y.

THEY PREFER TEXACO

★ More Diesel horsepower on streamlined trains in the U. S. is lubricated with Texaco than with all other brands combined.

★ More locomotives and cars in the U. S. are lubricated with Texaco than with any other brand.

★ More revenue airline miles in the U. S. are flown with Texaco than with any other brand.

★ More buses, more bus lines and more bus-miles are lubricated with Texaco than with any other brand.

★ More stationary Diesel horsepower in the U. S. is lubricated with Texaco than with any other brand.

ROCK DRILLS—a 36-page booklet of pictures and text to help you keep your rock drills on the job. Yours for the asking.

TUNE IN: "Treasury Hour—Millions for Defense." All-Star Radio Program. Every Wednesday Night, CBS. 9:00 E.D.T., 8:00 E.S.T.; 8:00 C.D.T., 7:00 C.S.T.; 6:00 M.S.T.; 5:00 P.S.T.

★ **RETURN METAL DRUMS PROMPTLY**... thus helping to make present supply meet industry's needs and releasing metal for National Defense. ★

TEXACO REG. T.M.

TEXACO Lubricants

FOR ALL COMPRESSORS AND AIR TOOLS

ANNOUN

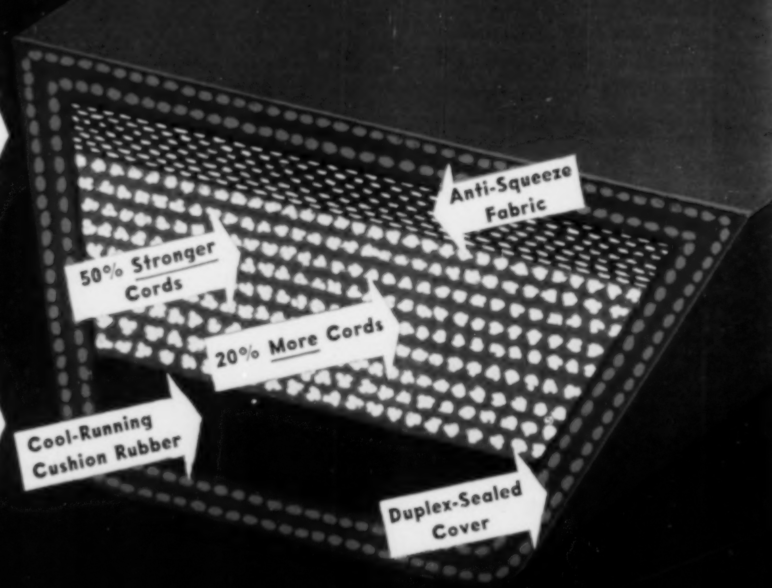
TEXROPE "SUPER-7"

1 50% STRONGER CORDS! Sensational new Flexon process makes cords 50% stronger than even those in former great Texrope belts.

2 20% MORE CORDS! Count them! You get 20% more of these tough, extra pulling power cords in every Texrope Super-7.

3 INCREASED LIFE! Cords float on amazing cool-running cushion rubber that absorbs shock...actually increases belt life phenomenally.

4 EXTRA PROTECTION! Exclusive duplex-sealed cover protects pulling cords against dirt, grit, moisture, and other adverse elements.


Anti-Squeeze Fabric
50% Stronger Cords
20% More Cords
Cool-Running Cushion Rubber
Duplex-Sealed Cover

ALLIS-CHALMERS MILWAUKEE A-C

CING *The New Wonder V-Belt...*

HERE'S A TRUE FACT: This new Super-7 Texrope* is by far *the best belt ever built by Allis-Chalmers,* originators of the multiple V-belt drive!

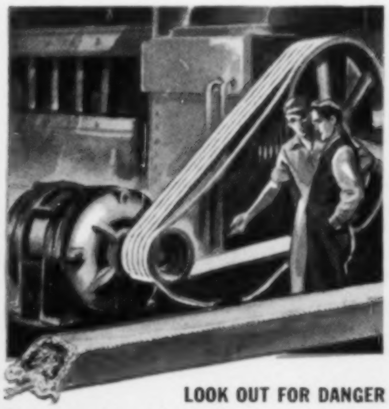
Flexon, a sensational engineering advancement in belt making, actually makes pulling cords 50% stronger . . . and adds years to belt life by preserving the exact ratio between strength and flexibility.

And there's 20% more of these heavy-duty, extra-tough cords — each imbedded in special heat-resisting rubber. Then, as an added safety factor against heat and resultant belt disintegration, we float these Flexon cords on cool running, live cushion rubber that's made to absorb terrific vibration and shock.

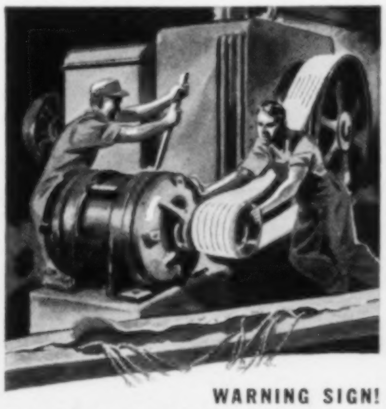
But we're not asking you to experiment with anything untried. Super-7 Texrope Belts have had to pass not only every laboratory torture test with flying colors — but before we put them on the market, *they had to prove their plus staying power in actual field tests for over four years!*

Why not be the first to get the advantages of the new Texrope Super-7? Call the Allis-Chalmers district office — or the Texrope dealer near you. Ask for Bulletin B6190.

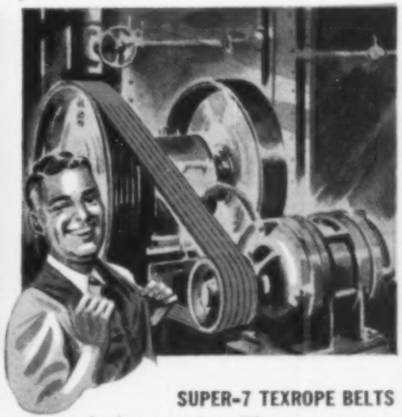
Available in All Sizes — ½ hp to 2000 hp.



LOOK OUT FOR DANGER in belts with stiff, unpliable cords! Such belts *look* strong . . . but actually they buckle over sheaves, build up excessive heat that attacks pulling cords. Result: Belt failure far sooner than you expect it.



WARNING SIGN! Sagging, slipping belts mean too much stretch not backed up by balanced cord strength. Motor must be pulled back often to take up slack. Result: When stretch limit is reached belt breaks under tension.

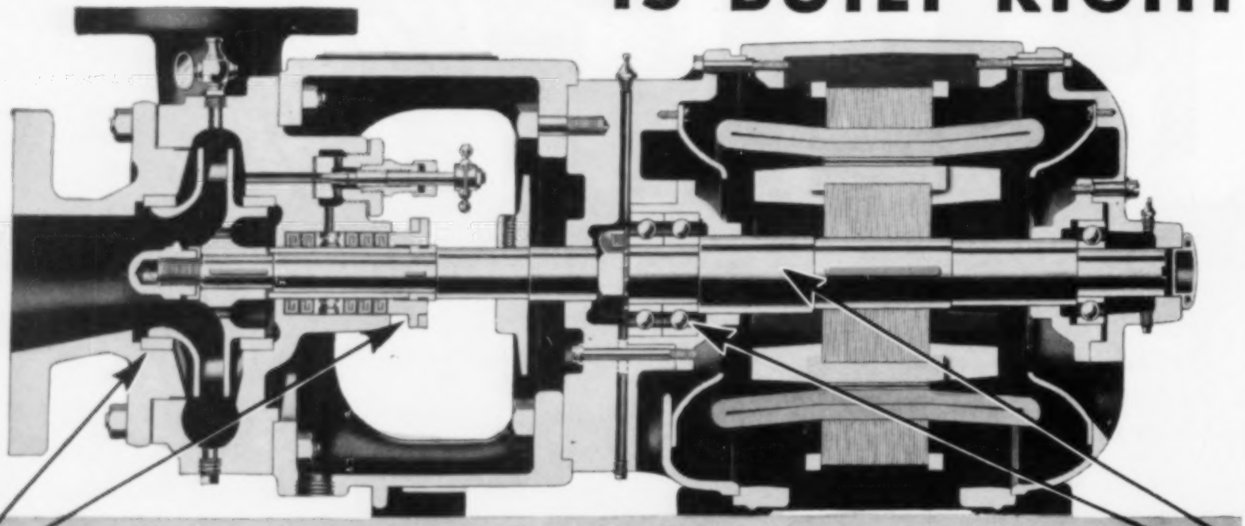


SUPER-7 TEXROPE BELTS are made by amazing Flexon process that *combines* flexibility with low stretch . . . great strength. Cords float on cool-running, shock absorbing cushion rubber. Result: *true* strength . . . *true* pulling power . . . *true* endurance. A 1421

*Trade mark registered U. S. Patent Office. Texrope Super-7 Belts are the result of the co-operative research and design genius of *two* great companies —Allis-Chalmers and B. F. Goodrich—and are sold exclusively by Allis-Chalmers.

ALLIS-CHALMERS
MILWAUKEE · WISCONSIN

The MOTOR PUMP IS BUILT RIGHT



The motorpump is a heavy-duty unit built to give many years of trouble-free service. Some of the features which make this possible are:

① A split stuffing-box gland plus ample space makes the pump easy to repack and encourages proper attention on the part of the operator.

② Renewable casing rings reduce leakage to a minimum and allows the original high efficiency of the unit to be restored after a number of years of use.

③ Ball bearings are used. These are larger than are found in a standard motor in order to carry the combined pump and motor loads. A cartridge-type bearing housing excludes dust and moisture.

④ The shaft is oversize. This makes a smooth-running unit with minimum shaft vibration, reduces air in the pump and stuffing box trouble.

⑤ A Standard motor of well known make is used. Motor service is available at the manufacturer's shop in all parts of the country.

Ingersoll-Rand

CAMERON PUMP DIVISION

11 BROADWAY, NEW YORK CITY

9-59

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YARD HANDYMAN

BUCYRUS ERIE
BUCYRUS ERIE
18-B
BUCYRUS ERIE

Waterbury Farrel Foundry
& Machinery Company of
Connecticut use this short-boom Bucyrus-Erie crane for odd jobs all over their yard.

YOU will find the following advantages in a Bucyrus-Erie crawler crane for similar work:

1. Complete range of sizes up to 72-ton ratings. Boom lengths to 100 feet.
2. Added material handling capacity without added demand on your regular power supply.
3. Full mobility to go wherever needed, whenever it is needed.
4. Complete utilization of existing yard space and easy addition of extra facilities with no need to construct tracks.

These are just a few of the ways a Bucyrus-Erie crawler crane can help solve your material handling problems in a hurry. Write us at once for the complete story.

B 68

Bucyrus·Erie

SOUTH MILWAUKEE, WISCONSIN

Because aluminum is vital

. . . they're routing a river through a mountain

Bethlehem Superior HOLLOW Drill Steel

At Nantahala, N. C., the Utah Construction Company is driving a huge water tunnel under five miles of mountain for the Aluminum Company of America. The tunnel will be 13 ft. x 16 ft.—big enough to accommodate a moving van. It will take water from a recently constructed dam, shoot that water downgrade to a 60,000 horse power generating station.

There the Aluminum Company of America will use the power to provide electricity to smelt aluminum for national defense. Bethlehem Superior Hollow Drill Steel (more than 100 tons to date) is being used on the job.

Bethlehem Superior is A-1 drill steel for any tough job. The hole in Superior is smooth, well-centered. The steel is tough and fatigue-resistant. Bethlehem Superior Hollow Drill Steel is excellently suited for use with detachable bits. It is turning in outstanding records on big jobs all over America.

BETHLEHEM STEEL

BETHLEHEM STEEL COMPANY

STOP

Heavy Carbon Deposits in Your Compressors with Highly Stable SHELL Compressa Oil

HIGH temperatures at the discharge valves hold no terrors for Shell Compressa Oil. Its high oxidation stability keeps compressors running smoothly, day in and day out, in the hardest kind of mining operation. Shell Compressa Oil—

1—Prevents excessive formation of hard carbon deposits . . . does not break down at high compression temperatures.

2—Keeps discharge valves working freely . . . prevents ring sticking and blow-by.

3—Reduces wear on all sliding and rotating parts.

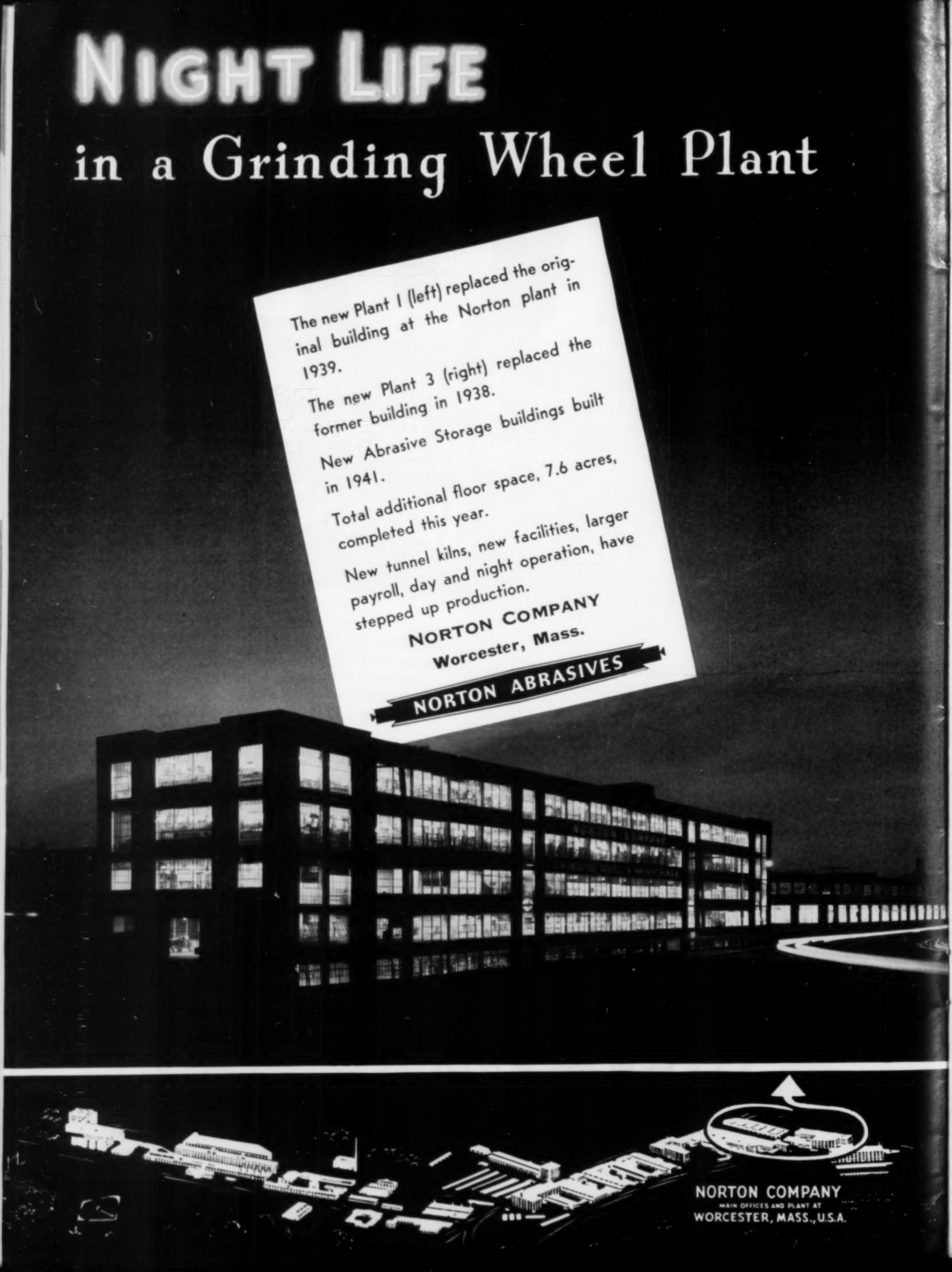
4—Has high resistance to emulsification . . . retains its lubrication qualities.

5—Assures low oil consumption by effectively sealing pistons.

GET THE DETAILS TODAY!

SHELL

SHELL Compressa Oil



NIGHT LIFE in a Grinding Wheel Plant

The new Plant 1 (left) replaced the original building at the Norton plant in 1939.

The new Plant 3 (right) replaced the former building in 1938.

New Abrasive Storage buildings built in 1941.

Total additional floor space, 7.6 acres, completed this year.

New tunnel kilns, new facilities, larger payroll, day and night operation, have stepped up production.

NORTON COMPANY
Worcester, Mass.

NORTON ABRASIVES

NORTON COMPANY
MAIN OFFICES AND PLANT AT
WORCESTER, MASS., U.S.A.

ON THE COVER

SEVEN years ago the Federal Government completed the National Archives Building in Washington. It is a huge limestone structure containing 4,000,000 cubic feet of space, and provision has been made for expanding it to 10,000,000 cubic feet. In this building Uncle Sam's records are being preserved for posterity by the latest scientific means. It is served by seven complete air-conditioning plants, and included in them is equipment for extracting sulphur dioxide from the atmosphere that is circulated. This gas deteriorates paper, causing it to turn yellow and to lose its strength and crumble. The documents, assembled in tiers and catalogued for ready reference, are periodically inspected and dusted. The latter work is done with a compressed air blow gun, as illustrated on our cover.

•

IN THIS ISSUE

THE Merriman Dam, which is the subject of our leading article, is the fountainhead of the Delaware Aqueduct. It will create Rondout Reservoir, from which will flow into the 85-mile tunnel leading to New York City all the water originating in the Catskill Mountains from the watersheds that are to serve the new system. The part of the dam that will never be seen after the structure is completed is the most interesting one from a construction and engineering standpoint. We refer to the cutoff wall that will form a watertight barrier in the unstable glacial soil that forms the surface of the valley of Rondout Creek. The author has rightfully devoted most attention to this phase of the operations; but other features of the $15,000,000 contract are adequately described. Merriman Dam is named for the late Thaddeus Merriman, for many years chief engineer of the Board of Water Supply of the City of New York.

•

THE article entitled *Air Conditioning on Wheels*, page 6533, contains essential information on the most popular equipment for cooling railway cars and automotive vehicles. It also hints at a future development: the mechanical refrigeration of railroad freight cars that now use ice. Sidelights on the Waukesha Railway Ice Engine that are not mentioned in the text are: The cost of the fuel (propane) it uses to produce a ton of refrigeration is 53 cents; and the units regularly operate automatically—that is, without being touched—on runs from Chicago to the Pacific Coast and return.

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TWO pages of pictures and a few inches of text show and describe the methods being used on the Great Plains to bury a double telephone cable that will eventually cross the continent.

Compressed Air Magazine

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Volume 46 **SEPTEMBER, 1941** Number 9

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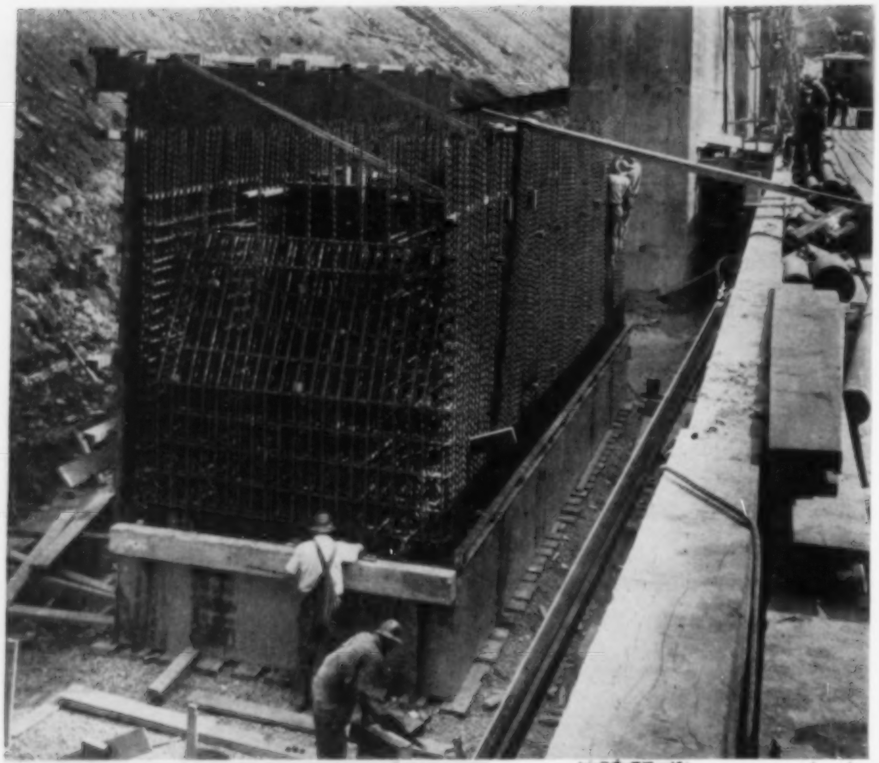
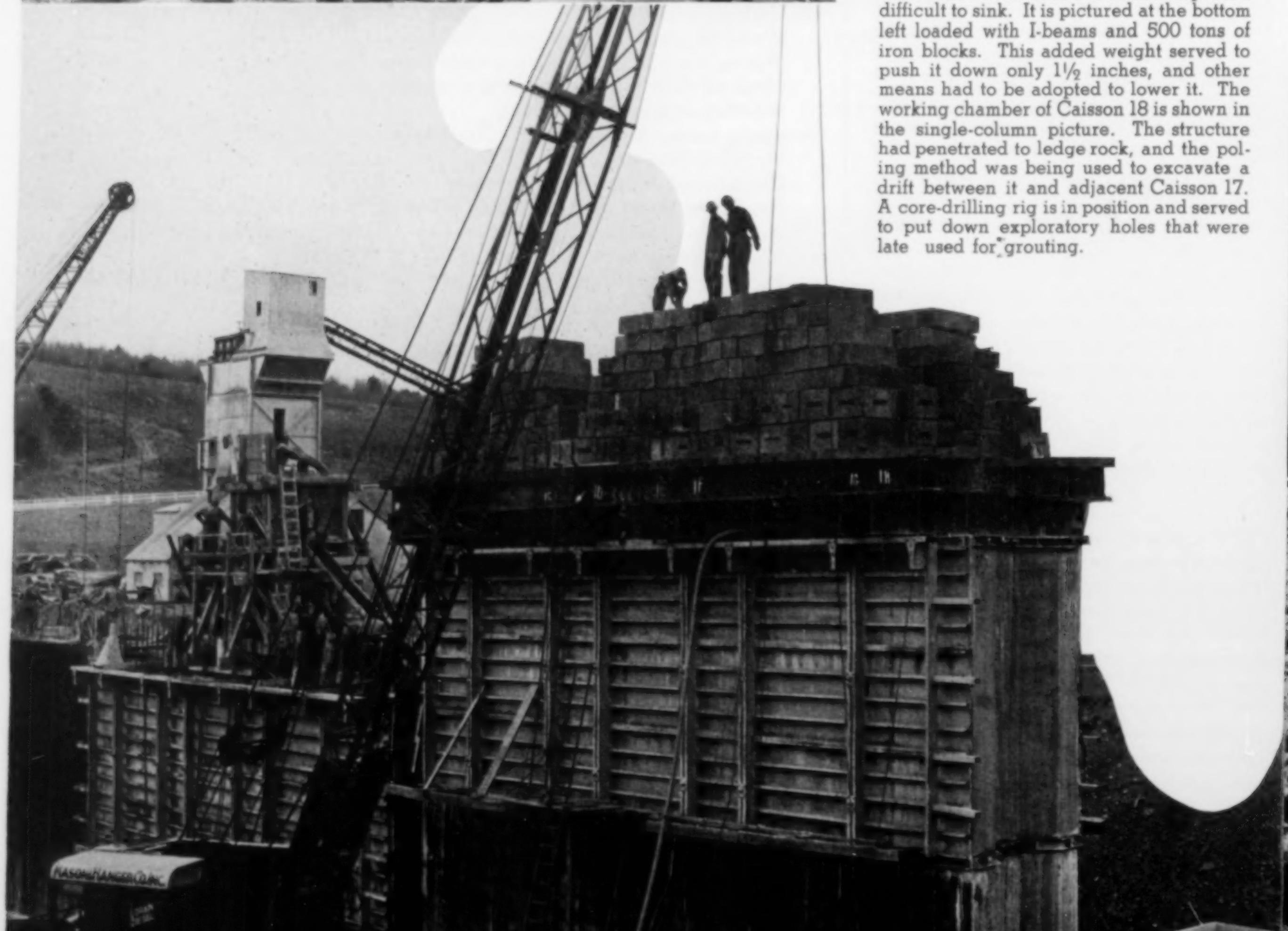
Building the Merriman Dam

John M. Ribble[*]



CAISSON-SINKING OPERATIONS

The central section of the 2,788-foot cutoff wall for the dam was built by sinking eighteen concrete caissons in addition to two experimental caissons. This section has a length of 920 feet, and the caissons were put down through water-bearing ground to depths of from 52.97 to 136.96 feet. At the bottom, right, are Caissons 9 to 18 in various stages of construction. No. 10, with a hopper on top, is being heightened by adding a lift of concrete. To the right and left of it are the exploratory caissons A and B. The bottom cutting edge and the surmounting reinforcing steel for the first lift of concrete of Caisson 6 are seen at the top left. Caisson 16 was one of three that proved difficult to sink. It is pictured at the bottom left loaded with I-beams and 500 tons of iron blocks. This added weight served to push it down only 1½ inches, and other means had to be adopted to lower it. The working chamber of Caisson 18 is shown in the single-column picture. The structure had penetrated to ledge rock, and the poling method was being used to excavate a drift between it and adjacent Caisson 17. A core-drilling rig is in position and served to put down exploratory holes that were later used for grouting.



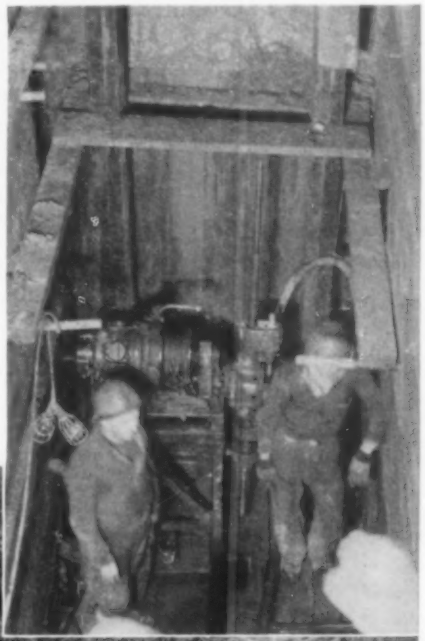
MERRIMAN DAM, which is being built by the Board of Water Supply of the City of New York across Rondout Creek on the southerly slopes of the Catskill Mountains, will create a reservoir that will impound the runoff of a watershed with an area of some 95 square miles. Rondout Reservoir, as it will be known, will be capable of storing approximately 50,000,000,000 gallons of water and is counted upon to provide the Metropolis daily with an added supply of about 100,000,000 gallons.

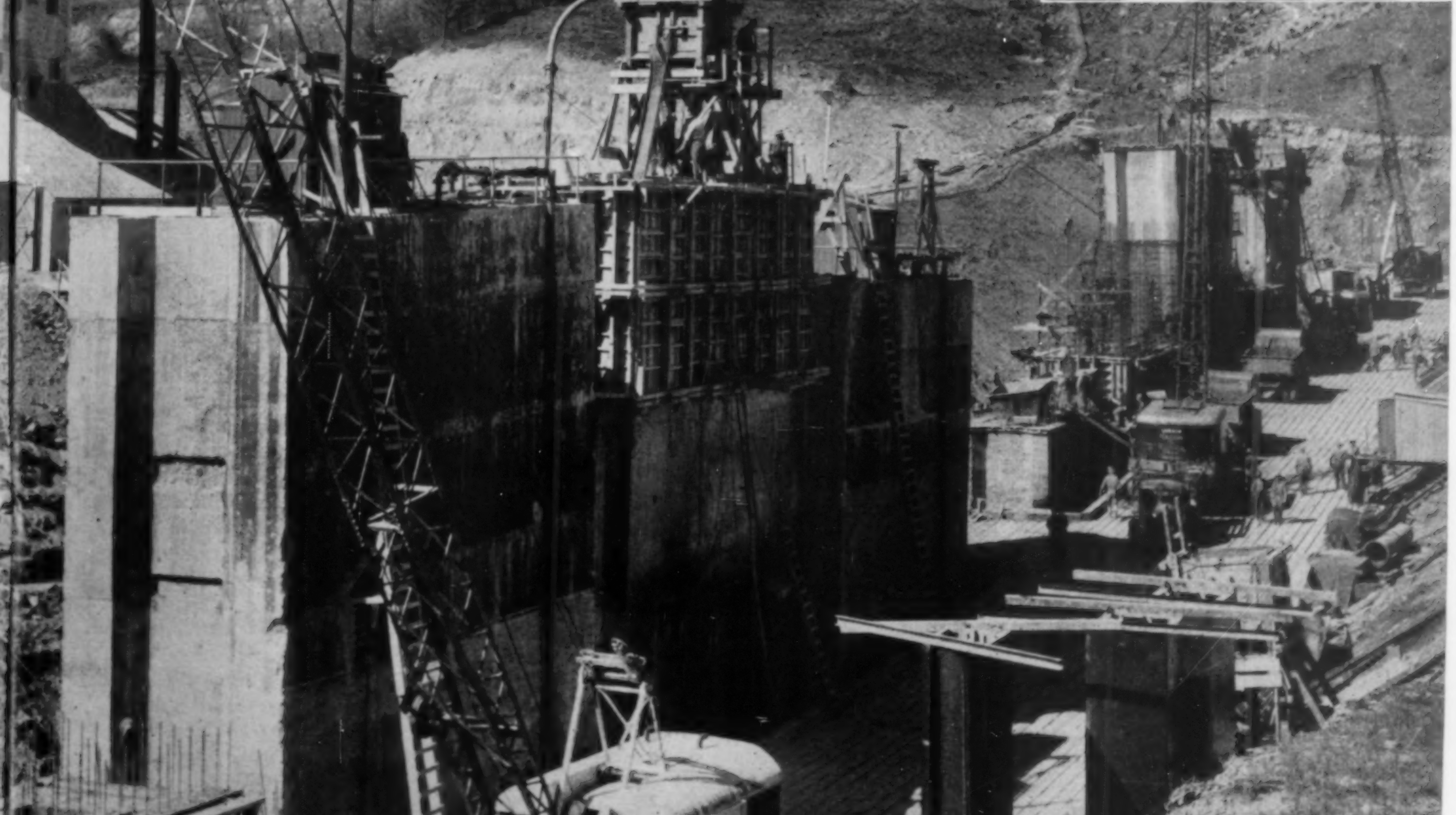
The axis of the dam crosses a U-shaped gorge that was carved during preglacial, glacial, and postglacial eras, as evidenced by the character of the overburden on the valley slopes and in the bed of Rondout Creek. The overburden on the slopes is from 20 to 60 feet deep, while that in the valley bottom has a maximum thickness of more than 180 feet down to the rock floor. The materials deposited there in the past are sand, gravel, silt, clay, and rounded boulders; and where the gorge is deepest, the underlying rock has been broken and disintegrated for some feet above the sound ledge rock.

The conformation of the valley at the dam site in the Village of Lackawack is favorable to the construction of a barrier with a maximum height of 200 feet above the stream bed; but the overburden that had to be penetrated to provide an axial cutoff wall for a rolled-earth dam presented difficulties. The ground conditions are much like those that were encountered in building the Wyman Dam in Maine in 1929, and the dam and dike for the Quabbin Reservoir between 1931 and 1935 The latter furnishes water to Boston. In each case it was decided to form a cutoff wall made up of a succession of concrete caissons bound together by concrete. In principle, the Board of Water Supply of New York City elected to do the same thing at Lackawack.

To prove that the course was practicable, two exploratory caissons—designated A and B—were sunk under Contract 338 on the axis of the projected dam and in the deepest part of the valley. The reasons for this advance work were that the ground-water table at the site is normally close to the surface, and that the ground-water pressure in the deepest section of the valley was found by test borings to be about 80 pounds per square inch. Furthermore, water issuing from the rock floor proved to have artesian heads ample to force the water even above ground level. The problem was how to deal with ground and artesian water so that the hydrostatic pressures could be lowered to a degree that would permit caisson sinking and the use of air pressures not exceeding the limit of 50 pounds prescribed by the laws of the State of New York for such work.

By recourse to deep wells sunk near the positions of Caissons A and B, and by equipping the latter with deep-well pumps, the ground-water plane was lowered and





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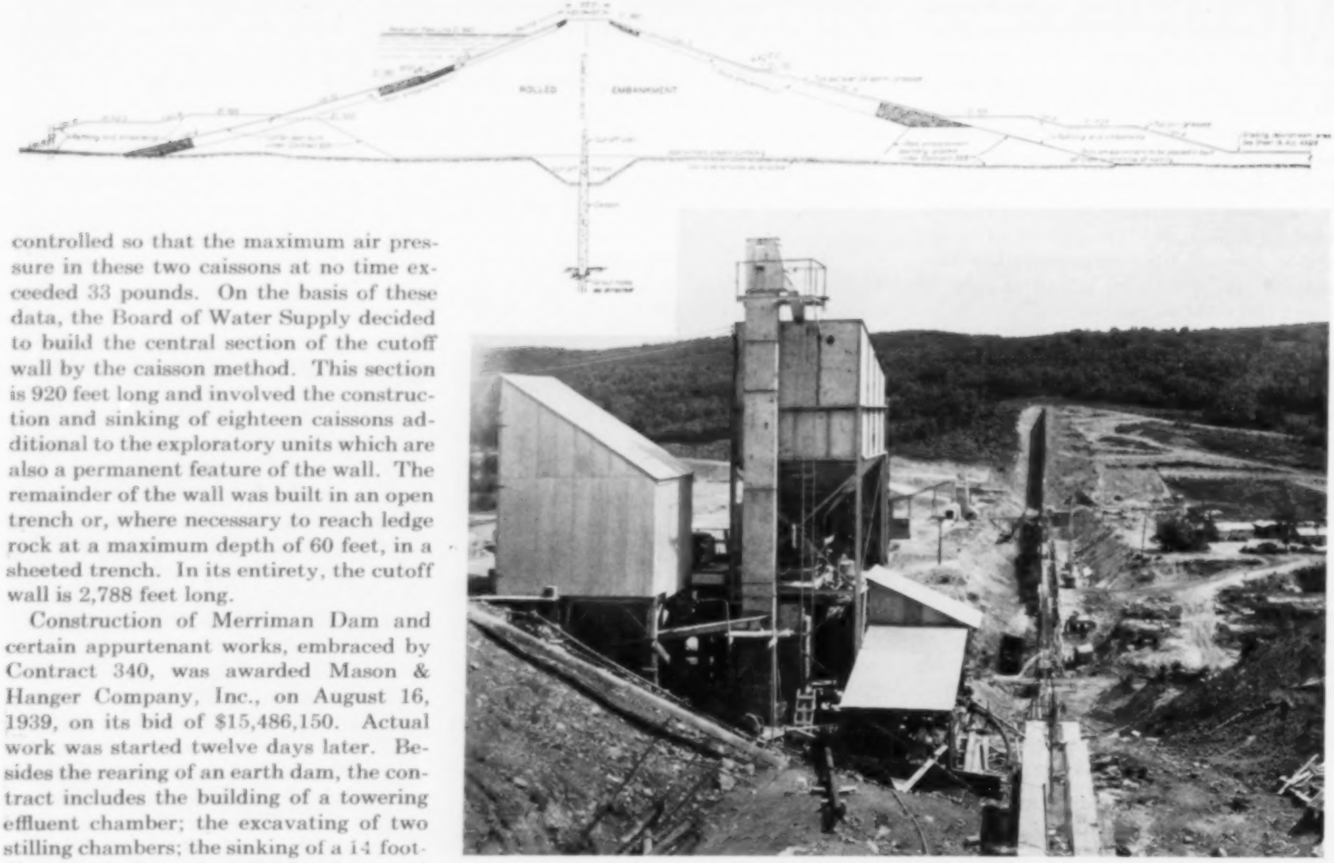
*Resident engineer for Mason & Hanger Company, Inc.



THE DAM LINE AND SECTIONAL DRAWING

At the top is a typical section through the dam, which will impound 50,000,000,000 gallons of water. So far the work has been confined to constructing the cutoff wall. Just above is a view along the axis of the dam, looking east. The caissons are in the middle distance. A small concrete mixing plant is in the left foreground, while the main plant is near the center of the picture and adjacent to the caisson area.

controlled so that the maximum air pressure in these two caissons at no time exceeded 33 pounds. On the basis of these data, the Board of Water Supply decided to build the central section of the cutoff wall by the caisson method. This section is 920 feet long and involved the construction and sinking of eighteen caissons additional to the exploratory units which are also a permanent feature of the wall. The remainder of the wall was built in an open trench or, where necessary to reach ledge rock at a maximum depth of 60 feet, in a sheeted trench. In its entirety, the cutoff wall is 2,788 feet long.

Construction of Merriman Dam and certain appurtenant works, embraced by Contract 340, was awarded Mason & Hanger Company, Inc., on August 16, 1939, on its bid of $15,486,150. Actual work was started twelve days later. Besides the rearing of an earth dam, the contract includes the building of a towering effluent chamber; the excavating of two stilling chambers; the sinking of a 14 foot-diameter shaft nearly 1,000 feet deep; and the driving of two tunnels—an inclined tunnel approximately 3,200 feet long from the stilling chambers to the shaft, which it meets at a point 431 feet below the collar, and a deep pressure tunnel, 13.5 feet in finished diameter, for a distance of 5,200 feet southeastward from the bottom of the shaft. All eighteen of the caissons have been sunk and sealed to the ledge rock; the excavation for the inlet channel and substructure of the effluent chamber has been completed as have been the excavations for the two stilling chambers which will be 86 feet long and have a diameter of 28 feet after they are lined; and the inclined tunnel has been holed through. Before this article appears in print, the placing of the earth in the embankments of the dam will be underway.

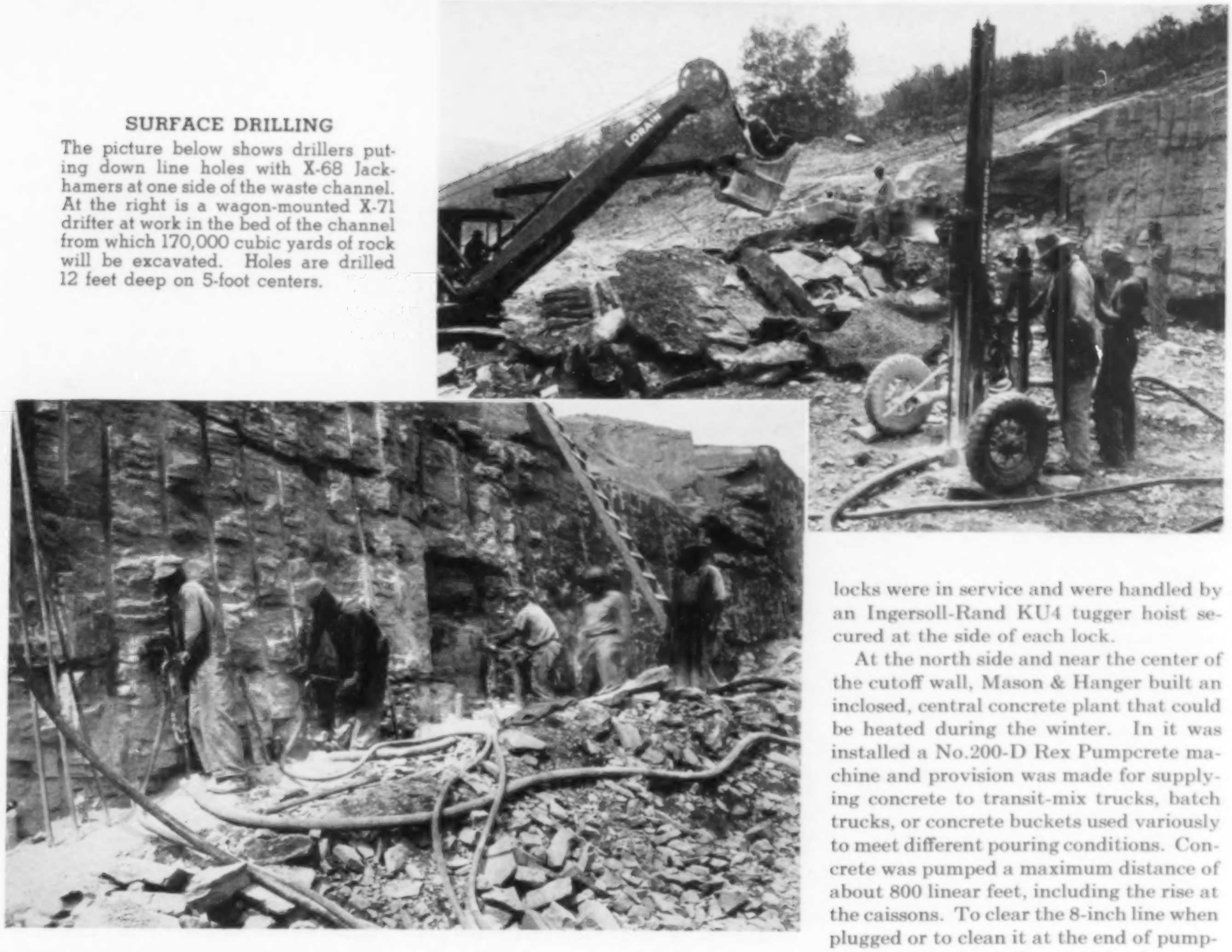
Perhaps the simplest way to describe this manysided contract will be to deal separately with its main features and to start with the caissons of the cutoff wall. As sunk, exploratory Caissons A and B had a minimum interval between them of about 40 feet. In this gap was placed one caisson 38 feet long, while each of the seventeen others was 45 feet long and from 10 feet to 12 feet in width. The wider units were sunk in the deeper ground and the 10-foot caissons in the shallower overburden towards the sides of the U-shaped gorge. Depth of penetration varied from a minimum of 52.97 feet below ground to a maximum of 136.96 feet—the latter being reached by Caisson 11, which is next to exploratory Caisson B.

Each of the eighteen caissons had a base section with an over-all height of 14 feet. The cutting edge was armored with a shoe of steel plates and angles anchored by steel tie rods to the tapering concrete walls of the working chamber which afforded a minimum headroom of 8 feet. Embedded behind the exterior and interior surfaces of the latter's walls were double rows of vertical and horizontal steel reinforcing rods to give ruggedness to the cutting edge. All other sections of the working chamber as well as the walls of the succeeding lifts of the caisson were reinforced with single rows of horizontal and vertical rods.

Piercing the roof of the working chamber were three openings leading to a man shaft in the center and to two muck shafts, one near each end. The latter were rectangular in plan—4 feet 7 inches wide and 7 feet 4 inches long. The shape and size were adopted to permit the use of clamshells in the chamber while excavating under free air. The man shaft—4 feet wide and 6½ feet long, was semicircular at one end to accommodate a 5-man cage hoist and square at the other to facilitate extending a ladder and platforms from top to bottom of the shaft. The cage was not installed until the caisson had attained a height of 60 feet above its cutting edge—the men using the ladder until then. The cage was operated by a 7½-hp. motor with an automatic solenoid brake and was raised and lowered in response to signals.

Each caisson was heightened by successively adding sections, each 15½ feet high, as the cutting edge worked deeper into the ground, or as more dead weight was required to force the caisson downward against skin friction. Embedded in its concrete walls from the top to the working chamber were as many as fourteen pipes for power, light, telephone, and signal circuits; for supplying high- and low-pressure air and water; and for chuting concrete. These pipes ranged in diameter from ¾ inch to 10 inches—the latter being employed to carry concrete for sealing the cutting edge. The high-pressure air was used to operate pneumatic tools and rock drills, the former for digging ground too hard for hand shovels and the latter for getting through unsound to sound rock in excavating the keyways by which the cutting edge was bound to the basic ledge with concrete.

It had been planned to sink the caissons with a gap of 18 inches between adjacent



SURFACE DRILLING

The picture below shows drillers putting down line holes with X-68 Jackhamers at one side of the waste channel. At the right is a wagon-mounted X-71 drifter at work in the bed of the channel from which 170,000 cubic yards of rock will be excavated. Holes are drilled 12 feet deep on 5-foot centers.

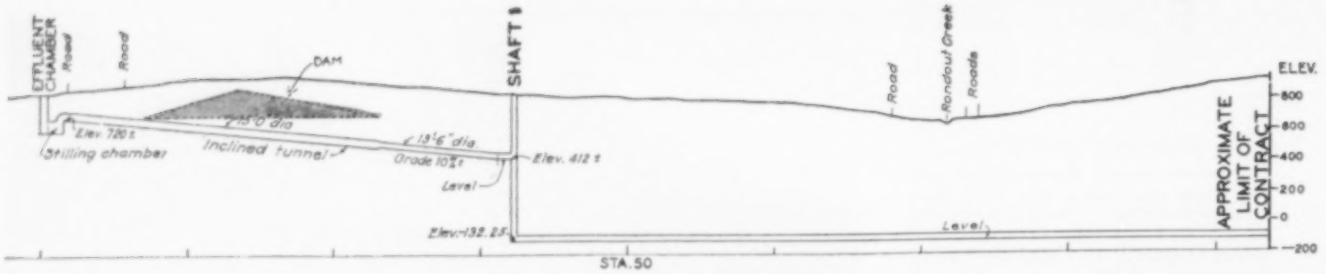
units, but difficulties encountered during the work made it impossible to keep them parallel and precisely that distance apart. At each end of each caisson, extending from a point 9 feet above the cutting edge to the top, was a recess or keyway 18 inches deep, and these served to bind the units into a consolidated wall when the intervening spaces were excavated and filled with concrete. This work was not started until the caissons had been sealed to the ledge rock.

To reduce the depth of ground to be penetrated by the caissons, a cutoff trench was dug along the axis of the dam. It had an average depth of 38 feet, a bottom width of 45 feet, and sides with a slope of 1 on 1.5. The contractor utilized gasoline and diesel-powered cranes, with booms from 40 to 100 feet long, in setting up the caissons, handling materials, and for operating clamshells in the working chambers. To this end was constructed an elevated platform or gantry along the south side of the trench on which to run the mobile equipment. The deck of the gantry roadway is 30 feet wide and 15 feet high where nearest the caissons and is built of 12x12-inch timbers laid on I-beams carried by timber bents. The latter support power, water, and air lines, as well as pump discharges. The whole arrangement has contributed greatly to ease and flexibility of operations.

While sinking a caisson under free air, excavating was done by a clamshell bucket in one muck shaft and by hand labor at the other. When the clamshell had dug a sump in the chamber below the level of the cutting edge, then the material was shoveled away from the cutting edge and piled centrally for removal by the clamshell working alternately through the two muck shafts. In harder ground, the muckers used L-54 paving breakers which could be equipped with spadelike blades 3 inches wide. The material hoisted to the surface by the clamshell was dropped into 5-cubic-yard motor trucks that hauled it to a nearby spoil bank. When a caisson reached water-bearing ground that necessitated placing the working chamber under compressed air, then each of the three shafts was fitted with an air lock. That on the man shaft had two tiers of seats for 24 workers and served also as a decompression chamber, the practice in that case being to reduce the pressure at the rate of 1 pound per minute. Buckets were substituted for the clamshells when the muck locks were in service and were handled by an Ingersoll-Rand KU4 tugger hoist secured at the side of each lock.

At the north side and near the center of the cutoff wall, Mason & Hanger built an inclosed, central concrete plant that could be heated during the winter. In it was installed a No.200-D Rex Pumpcrete machine and provision was made for supplying concrete to transit-mix trucks, batch trucks, or concrete buckets used variously to meet different pouring conditions. Concrete was pumped a maximum distance of about 800 linear feet, including the rise at the caissons. To clear the 8-inch line when plugged or to clean it at the end of pumping, a go-devil of oil-soaked burlap was blown through it with high-pressure air. After the concrete was placed in the forms it was mechanically compacted—a number of Ingersoll-Rand 2V pneumatic vibrators being utilized for the purpose. Both steel and wooden forms were used for the working chambers, collapsible steel forms for the three caisson shafts, and steel-plate forms that could be erected or removed with ease were employed for repetitive operations.

In virtually every instance the caissons, when sunk, were underpinned by side and end walls to tie them to the rock. These reinforced-concrete walls differed in thickness, depending upon the ground to be supported and the dead weight of the caisson. They ranged in height from 2 feet to 32 feet; and, where essential, pipes were passed through them to permit grouting outside to fill any remaining voids. They were poured behind wooden forms, and the concrete was lowered in buckets down the muck shafts. Where the rock exposed in the working chamber was disintegrated, it was excavated down to sound rock. At the same time the ground under one of the interspaces was excavated to the adjacent caisson, the superposed material being supported by poling boards carried on beams.



PROFILE SKETCH

Here are shown the principal features of the work being done under the $15,486,150 contract of Mason & Hanger Company, Inc.

With these operations completed, the concrete seal was placed by the Pumpcrete machine until it was up to a level 2 feet above the cutting edge in the working chamber and the adjoining excavation under the interspace was filled. This method of dealing with the interspaces to avoid excavating from the surface downward was followed in all cases save that between Caisson 9 and Caisson A, where the interval was too wide to safely support the overlying material during the driving of an underrunning drift. Pumpcrete was successfully delivered to the working chambers while they were under air pressure, which had to be maintained the while to exclude ground water. The practice was to hold the pressure for 24 hours after placing the bottom concrete seal and then to allow the compressed air to bleed off gradually.

The compressor plant for the caisson-sinking operations was established on the south side of the cutoff trench and contained both low- and high-pressure machines. For emergency use there was available a high-pressure Type K500 portable compressor that has been employed since then for chipping, drilling, vibrating concrete, and for other services both on the cutoff wall and at the concrete plant.

Work on the eighteen caissons was begun on January 2, 1940, and the last unit was sealed to the rock on January 23, 1941. Within that interval the caissons were sunk or underpinned an aggregate distance of 2,071.8 linear feet. By the end of April all the spaces between them were filled with concrete from top to bottom. As the sinking operations did not proceed without difficulties, it might be well to describe how some of them were overcome. Exploratory Caissons A and B each had a maximum dead weight of 6,660 tons, and at no time did top weights have to be placed on them to cause them to sink when their cutting edges were undermined. The eighteen caissons covered by Contract 340 were too light to perform in the same way—they were repeatedly held up by skin friction when passing through some of the formations in the ancient bed of Rondout Creek. Caissons 9, 14, and 16 were notably hard to move at times; but reference will be made to only one of them because all three presented similar problems.

Eight of the caissons were equipped with high-pressure-air jetting pipes, with 1-inch outlets arranged horizontally in the long sides. These effectually aided sinking under certain conditions; and the air was "blown" in the customary way to promote sinking. This consisted of filling a working chamber with air at 30 or 40 pounds pressure and then abruptly venting it to about atmospheric pressure. It was akin to suddenly adding dead weight, and was often successful in overcoming ground resistance. But now let us see what had to be done in getting Caisson 16 down through about 33 feet of ground when approaching ledge rock. That descent was achieved only after 112 days of diversified efforts.

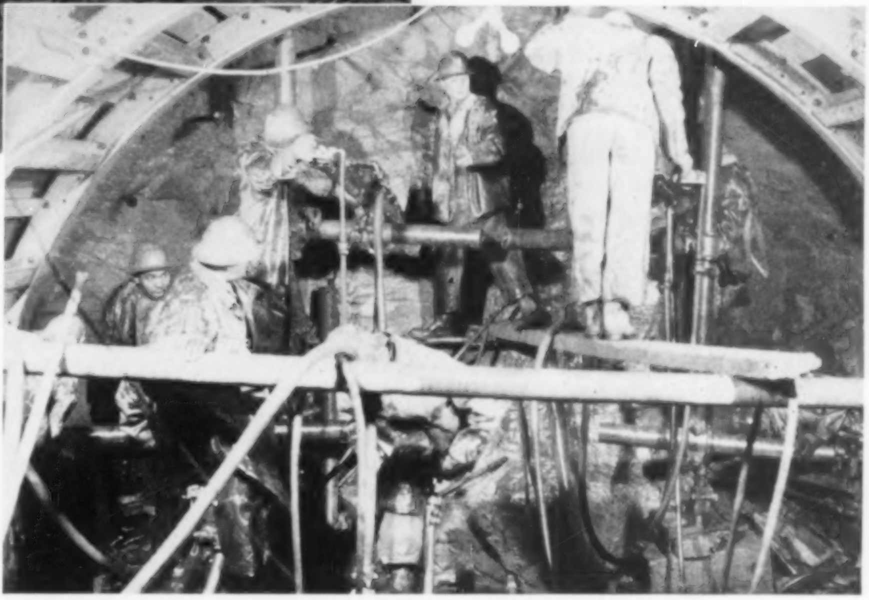
When Caisson 16 was 64 feet in the ground, it hung up even when its cutting edge was undermined 3.5 feet. As many additional lifts as practicable were placed on top to increase its weight, but it remained stationary for nearly a month. Charges of explosive both inside and outside the working chamber were next tried. The excavation under the caisson was filled with water to within 6 inches of the cutting edge; but the firing of 25 sticks of dynamite submerged failed to shake the structure loose. When 500 tons of iron weights were set on top of it it settled but little—not more than $1/10$ foot. At that impasse the two rectangular muck shafts were converted into smaller circular shafts, 3 feet in diameter, by filling the remainder of the space with concrete. This was equivalent to 2 cubic yards of concrete for each vertical foot of caisson. But that increased weight was not effective in itself.

In a further effort to induce sinking, four holes, each 40 feet deep, were drilled 5 feet away from the caisson and about 10 feet from the ends—two holes on each side. They were bottomed about 26 feet above the level of the cutting edge, and each hole was loaded with approximately 37 pounds of 100 per cent dynamite—the sticks being alternated with tamped earth. This work was directed by a powder-company expert. When the charges were set off, the surrounding ground and the caisson were vigorously jarred, but the structure remained virtually unmoved. The blast did some damage to the caisson, which was afterward repaired by grouting.

It was then decided to excavate the ground outside the caisson from the cutoff trench down to the point where the ground held the structure. At that time it weighed about 3,000 tons, and the frictional resistance that stopped sinking was probably in excess of 2,000 pounds per square foot of exposed surface. Excavating was carried down to within 30 feet of the cutting edge, but the area had to be extended longitudinally before the caisson started to sink and to settle 3.3 feet. Mucking in the working chamber was resumed immediately after that subsidence; but again the structure did not respond as expected. More dead weight was added by placing another lift of concrete on top; and so, by intermittent stages, the box was got down to its ultimate depth—the last drop of a few feet being through a stratum of running sand that caused trouble before it was effectually checked. The ledge rock under Caisson 16 dips steeply; and when one end of the cutting edge was in contact with the rock, the opposite end was about 25 feet above the ledge. The underpinning wall at that point therefore had to be built that high to give the latter end proper support. Because of favorable ground-water conditions the concluding work was done under free air.

Every effort was made during sinking to keep the caissons as nearly plumb as practicable. When they could not be controlled by familiar mining methods, directive force was applied externally above ground by struts and long shores canted against the ends and sides. Of the eighteen caissons, three were kept within the permissible tolerance of 12 inches for either tilt or drift and ten within a maximum variance of 2 feet. Caisson 10, which is 154 feet high and was sunk 124 feet into the ground, was the outstanding exception: it reached its final position with a maximum drift of 3.56 feet and a transverse tilt of 4.7 feet. Of the eighteen sunk under Contract 340, Caisson 11 was carried deepest: its cutting edge rests about 137 feet below the bottom of the cutoff trench.

Underground caisson work will be concluded by pumping concrete into each working chamber up to a point one foot above the lower openings of the three shafts and by filling the latter with carefully selected and puddled earth. Wherever possible, the excavating of the spaces between the caissons was done in free air



UNDERGROUND DRILLING

Left—Top heading in the 3,200-foot inclined tunnel driven from a point in the shaft 438 feet below the surface to the stilling basins into which the effluent chamber will discharge. Four DA-35 drifter drills, mounted on two columns, put in 40 holes to a round. The remaining bench was drilled with Jackhamers. Work is now in progress on the 5,200-foot-long deep pressure tunnel that is being advanced from the bottom of the 1,000-foot shaft. The picture below shows DA-35 drifter drills working in that bore.

—the side openings being closed with wooden sheeting. When ground water arrested this procedure, then a muck lock and shaft were placed at the top in a concrete plug 30 feet deep, and the work carried down to the bottom seal previously poured under compressed air. When the last of the earth was removed and the adjacent keyways were cleaned, then the caissons were bound together by filling the spaces with concrete.

During caisson sinking, the groundwater level was controlled by pumping from two deep wells, from drains connecting with the pump chambers in exploratory Caissons A and B, and by deepwell pumps temporarily installed in the other caissons when necessary. The practice was to use the low caisson of a group as a sump. It was found that even a very small quantity of water would, if allowed to build up a head, give considerable trouble during excavating. By pumping as little as 5 gpm. from a caisson, the ground-water level could be lowered as much as 20 feet in 48 hours—reducing proportionately the head that had to be counteracted. On Sundays the contractors kept the working chambers under compressed air to prevent flooding. This saved time and pumping when work was resumed. The maximum air pressure used in any working chamber was 46 pounds, and was required while making connections in the interspaces between the bottom structures of adjacent caissons.

Now we come to the shaft. After it had been sunk with the aid of a crane to a depth of 100 feet, a headframe, said to be the heaviest in use on the aqueduct, was erected to carry it to the bottom at Elevation -132.25. Shaft sinking was done with JA-55 Jackhamers. From Elevation 474 downward for the succeeding 40 feet the shaft has a conical form that widens out to 40 feet, finished diameter, at which it continues for 40 feet and then diminishes gradually for 22 feet to a diameter of 14 feet, which is the general diameter. After the shaft had been sunk and the heading turned for driving the deep pressure tunnel, the 40-foot chamber was spanned at Elevation 412, approximately 438 feet down from the top of the shaft, with I-beams and floored to form a platform from which to start work on the 3,200-foot inclined tunnel leading to the stilling chambers that will connect with the effluent chamber. The first 150 feet of the tunnel was driven level, and from there up to the stilling chambers it is on about a 10 per cent grade. The level stretch was provided to facilitate moving cars off and on the platform and for safety of operation in that area. For the lower third of its length, this tunnel will have a diameter of 13.5 feet after it is lined, while the upper two-thirds, except for an intervening transition section, will have a 15½-foot horseshoe shape. Just before reaching the stilling chambers the tunnel terminates in two short downward-curving tunnels, each 13.5 feet in diameter, which open into the top and rearward ends of the chambers.

The rock perforated is a horizontally bedded gray sandstone, and the tunnel was advanced by the heading-and-bench method. Ingersoll-Rand DA-35 power-feed drifters set on two columns were used in drilling a round of 40 holes, each 12 feet deep, at the 8-foot-high heading, while JA-55 Jackhamers drilled eighteen 9-foot holes in three rows across the bench, which was 8 feet high and 25 feet long. Both rounds were shot simultaneously with nine delays and about 450 pounds of explosive per round. At each shot a pull of 10 feet was made at the heading and about 9 feet at the bench. The daily advance averaged 20 feet, and the work was carried on in three shifts 24 hours a day and six days a week.

The slope of the inclined tunnel was too steep to permit the employment of a drill carriage and storage-battery locomotives. Hauling was done by a cable system using two hoists—one permanent and one movable—which avoided such complications as a signal system, trolley, etc. The movable hoist served until the bore was 1,700 feet in from the shaft. Then the permanent one was established at the 1,500-foot point and the movable one took up its work at different stations farther along as tunneling progressed.

An electrically driven mucker of the

scraper type was used at the heading and was located from 50 to 75 feet back of it. The double-drum hoist, which pulled and retracted the scraper, operated through pulleys attached to two deadmen at the heading. The excavated material was pulled up to the top of the machine and dumped in a 5-cubic-yard car spotted beneath and to the rear of it. When full, the car was connected to the line of a 30-hp. air hoist, mounted at the rear of the mucker, and allowed to run by gravity to a California switch while the same hoist pulled an empty, that had been standing on the other track of the switch, to the loading station.

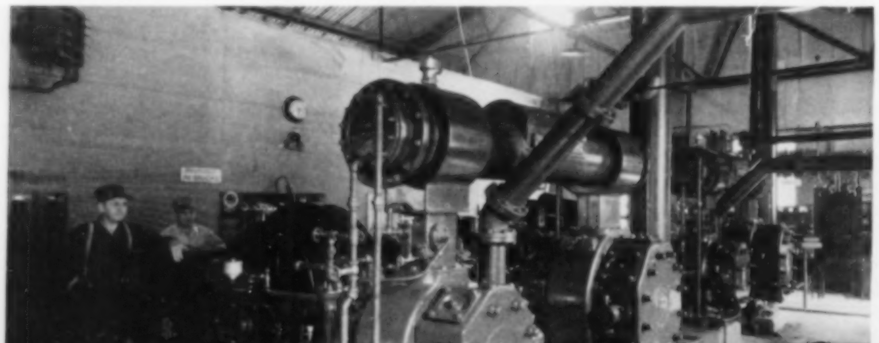
One by one, the loaded cars passed through and beneath the straddling frame of the movable haulage hoist to reach the switch, and when a train of three cars was assembled, the latter hoist hooked on to them and paid out its connecting cable until the train reached the fixed hoist located upgrade from the first switch in the level stretch of the tunnel near the shaft. An HU hoist at that switch and another HU on the cage platform in the shaft served to shift loaded and empty cars back and forth from these two stations. The loaded cars were raised directly to the tipple in the headframe and dumped into a hopper that has a pneumatic gate and discharges into trucks for final disposal. The California switch was moved forward in the tunnel once a week to a point about 400 feet back from the heading.

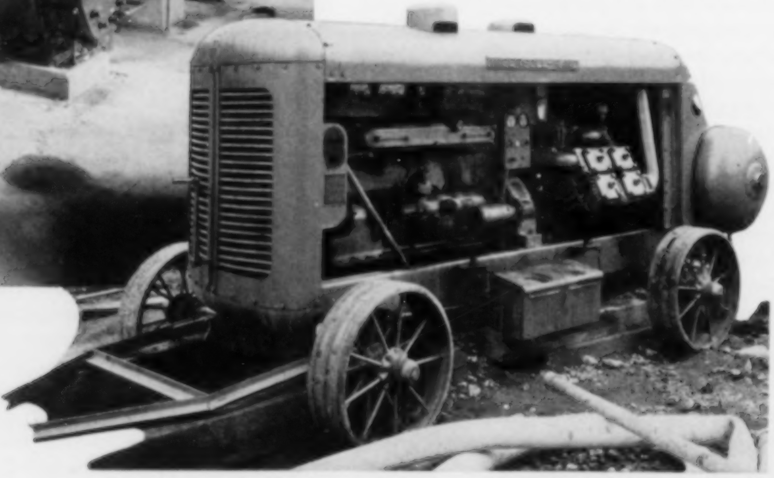
The transportation arrangement worked with satisfaction and the mucking procedure permitted setting up the drill columns and starting a round before all the material was removed from the bench. Approximately six hours were spent in mucking after a shot; and from 36 to 38 cars were needed to handle the rock from a round. The tunnel averaged 11 cubic yards of material per linear foot of advance and was holed through early in August. Upon completion of the excavating, the shaft end of the tunnel will be temporarily closed and the cage platform removed so that work on the 5,200-foot deep pressure tunnel can be started. Access to the inclined tunnel for lining operations will be by way of the upper end. The horseshoe-shaped section will have a series of five longitudinal walls rising to a height of about 4 feet from the concrete invert. These will reduce the velocity of the water pouring downgrade; and the large chamber in the shaft at the outlet of the tunnel is designed to break up the discharge and to check any surge.

Both the tunnel and the shaft were ventilated by means of an Ingersoll-Rand Type FS reversible blower of 7,000 cubic feet capacity. The fumes were cleared away in 30 minutes after a shot so that the men could return to the heading; and it required about three hours elapsed time to set up, drill, and take out the drills during a shift. The drill steels used were conditioned in a blacksmith shop equipped with two No.27 oil furnaces, two No.50 sharpeners, two Ingersoll-Rand LP punches, one No.500 cutoff machine, and one No.8 pedestal grinder, and were moved between the blacksmith shop and shaft in cars pulled by an HU hoist. Air for operating rock drills, pneumatic tools, etc., is furnished by two PRE-2 compressors driven, respectively, by a 250- and a 225-hp. General Electric motor. The machines have full automatic control, and each has its own aftercooler.

The effluent chamber will occupy an open pit, more than 150 feet deep, in rock, and will connect with Rondout Reservoir by a large canyonlike inlet channel that has been drilled in the ledge rock. At one side of the effluent-chamber excavation, Mason & Hanger is driving a blow-off tunnel that will have a finished cross section of 4½x6 feet. This bore is being ventilated by an Ingersoll-Rand blower, and I-R air hoists serve to pull the loaded muck cars to the tunnel portal and thence to two rotary car dumpers also operated by air hoists.

The rolled-earth body of the Merriman Dam will contain approximately 6,000,000 cubic yards of material that will be obtained from a deposit of glacial till high on the eastern slope of the valley and about a mile upstream from the dam site. In its finished form the crest of the structure will be substantially 2,500 feet long and 60 feet wide, and will carry a gravel-paved roadway 18 feet wide. The maximum transverse base spread will be about 1,800 feet. The upstream slope will be protected against wave action and floating ice by a blanket of massive riprap, while the downstream slope will be faced with a heavy rock blanket covered with earth carrying top soil that will be sown to grass.





AIR COMPRESSORS

During the sinking of the eighteen caissons for the cutoff wall, air pressures up to 46 pounds per square inch were maintained to exclude water. This air was supplied by the two Class PRE single-stage Ingersoll-Rand compressors shown at the left. Each has cylinders of 29-inch diameter and 21-inch stroke and a rated piston displacement of 5,750 cfm. A K-500 portable compressor, below, supplied air for miscellaneous uses at the cutoff wall and in the concrete mixing plant.

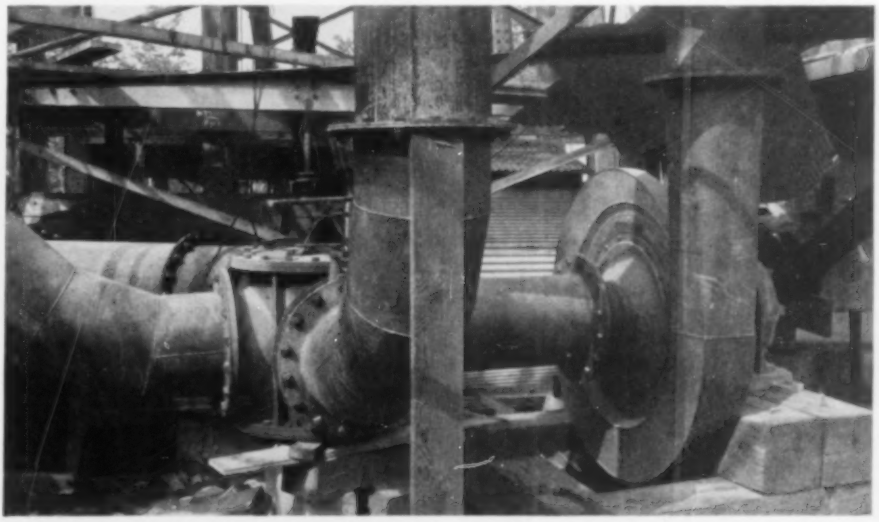
PERSONNEL

Left to right- Harvey Ury, tunnel superintendent; William Jones, walking boss; William Knox, shaft superintendent; Jack Spraker, electrical superintendent, all of Mason & Hanger Company, Inc.; Ed Brewster, in charge of equipment; and A.J. Brewster, in general charge of the work being done by George M. Brewster & Son, Inc.

The earth embankments of the dam will be placed by George M. Brewster & Son, Inc., under a subcontract with Mason & Hanger. The Brewster Company has equipped its borrow area with a large grizzly that will produce material in which no piece of rock will exceed 5 inches in size. The glacial till will be loaded with 2½-cubic-yard shovels into 10-cubic-yard trucks for delivery to the grizzly and will be hauled to the dam site in 14-cubic-yard Euclids. There it will be spread by bulldozers in layers not more than 7 inches thick when loose, and sheep's-foot rollers will be used to give it the right degree of compaction. This will be determined repeatedly in the course of the operations by test; and the deposited material must meet exacting specifications as to quality and moisture content at the time of placing. The intention is to make the body of the dam virtually impervious throughout. The Brewster Company is required to do its work on the rolled-earth dam in about three seasons. Operations can be carried on only for about 100 days a year because the soil cannot be incorporated in the dam in rainy or winter weather when it is wet or frozen. Therefore, when conditions are favorable, the subcontractor will have to place material at the rate of 25,000 cubic yards a day.

When Rondout Reservoir is filled, excess flood water will escape over a 600-foot-long spillway or masonry weir to be built under Contract 340 and will fall into an inclined tunnel, 30 or more feet in diameter, connecting with a diversion tunnel 30 feet in finished diameter. The diversion tunnel is 2,445 feet long and is provided with an outlet channel of special stepped design. The two tunnels and the outlet channel were constructed by B. Perini & Sons, Inc., under Contract 339. The diversion tunnel was a necessary preliminary to starting work on the Merriman Dam because Rondout Creek is a flashy mountain stream. Records show a maximum flood flow of as much as 27,000 second-feet, although the average is less than 250 second-feet. The spillway tunnel is designed to handle 50,000 cubic feet a second, and the spillway as much as 100,000. Any excess that cannot be carried off by the spillway-diversion-tunnel outlet will escape through an emergency wasteway now being excavated in rock under Contract 340 and as part of a subcontract with George M. Brewster & Son. It is an open cut that overruns the line of the diversion tunnel and will drop the water carried by it into the already constructed outlet channel leading from the diversion tunnel to Rondout Creek below the dam.

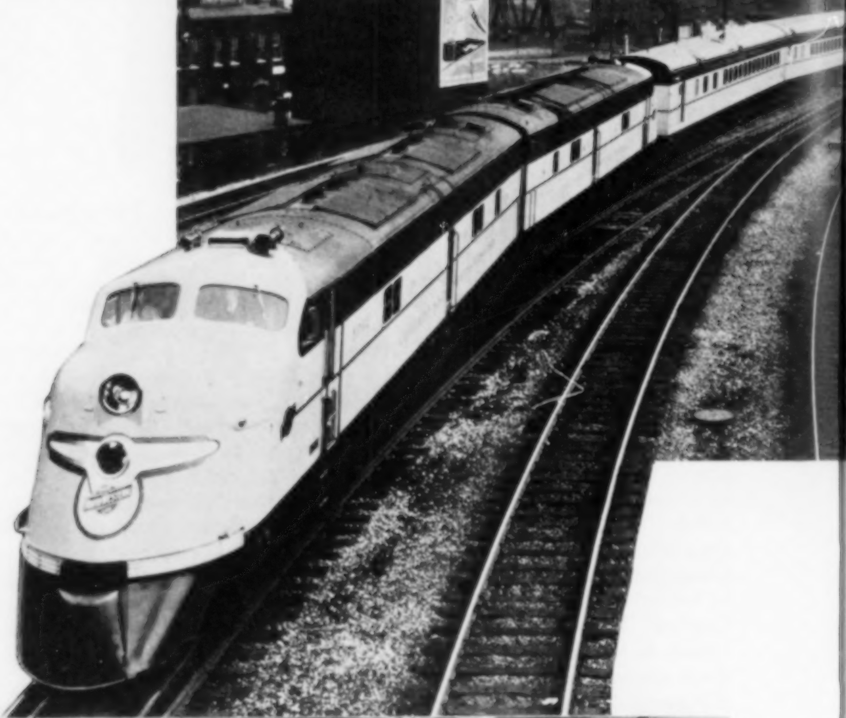
The work is being carried out by Mason & Hanger Company, Inc., of which Miles I. Killmer is vice-president and general manager, Guy W. Sackett is job manager, and Howard L. King is chief engineer. The author is resident engineer; William B. Ury, general superintendent; Harry F. Stripling, caisson superintendent; and Harvey Ury, tunnel superintendent. The structures were designed and construction is being supervised by the Board of Water Supply of the City of New York, with Charles M. Clark, chief engineer; James A. Guttridge, department engineer; N. LeRoy Hammond, division engineer; Charles G. Hoerner, senior section engineer; and Herbert A. Dibbell, section engineer.



VENTILATING BLOWER

An Ingersoll-Rand Type FS reversible blower with a capacity of 7,000 cfm. was used to ventilate the shaft and the inclined tunnel driven from it.

Greyhound Lines

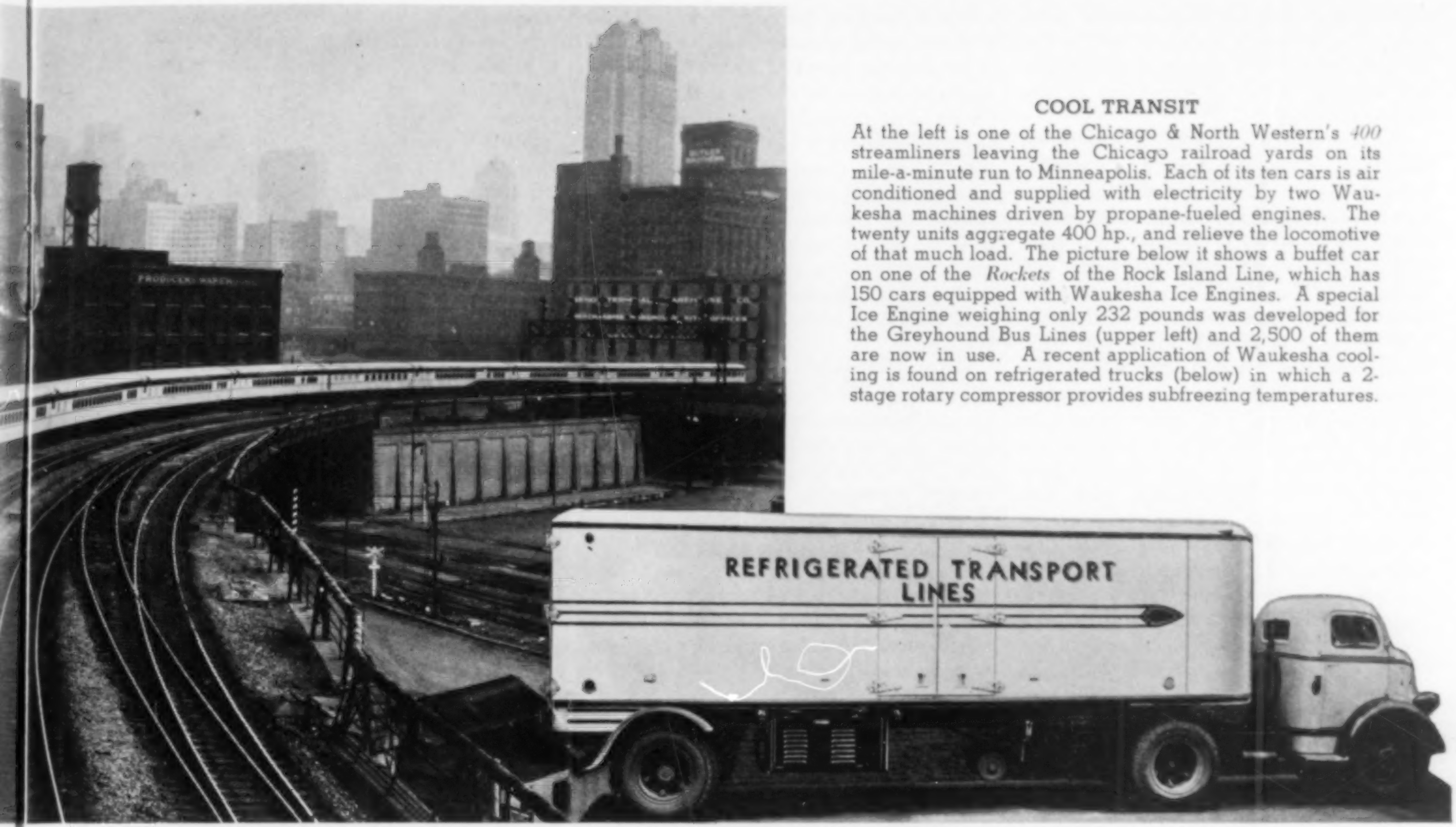


Air Conditioning on Wheels

C. H. Vivian

MANY of our readers who were born before automobiles, motion pictures, radio sets, and other modern means of divertisement came upon the scene will recall Miss Phoebe Snow, one of the best-known characters of her day. Miss Phoebe never drew a breath. She lived only in the advertisements of the Delaware, Lackawanna & Western Railroad and personified cleanliness. Always clad in spotless white, she rode the "road of anthracite." And, so the copywriter said, she always arrived at her destination in unsoiled condition because she was drawn by a locomotive that burned only hard coal. Phoebe did a good selling job, and there was no doubt some merit in her message; but even her sponsors probably would admit that the best trains they sent out in that era were grimy compared with today's luxurious air-conditioned flyers. One doesn't have to be old enough to vote to remember when any lengthy summertime railroad trip left impressions on person and clothes that only soap and water could remove. Yet, by contrast, a traveler can now traverse the continent, even during the most torrid weather, without soiling his shirt or requiring the porter's traditional brush-off.

The application of air conditioning to railway passenger cars was a natural outgrowth of the public's response to the added comfort afforded by buildings so conditioned. The first successful cooling of a motion-picture theater in 1922 led similar establishments and a scattering of restaurants and hotels to follow suit, and as early as 1924 some far-seeing railroads began investigating the possibility of providing patrons with manufactured weather. The era was a prosperous one for most railroads; but they were already beginning to feel the pinch of competition offered by the automobile. It was evident to them that they had to improve their service to arrest the trend away from rail travel. Air conditioning and faster schedules were two means by which this could be done.



COOL TRANSIT

At the left is one of the Chicago & North Western's *400* streamliners leaving the Chicago railroad yards on its mile-a-minute run to Minneapolis. Each of its ten cars is air conditioned and supplied with electricity by two Waukesha machines driven by propane-fueled engines. The twenty units aggregate 400 hp., and relieve the locomotive of that much load. The picture below it shows a buffet car on one of the *Rockets* of the Rock Island Line, which has 150 cars equipped with Waukesha Ice Engines. A special Ice Engine weighing only 232 pounds was developed for the Greyhound Bus Lines (upper left) and 2,500 of them are now in use. A recent application of Waukesha cooling is found on refrigerated trucks (below) in which a 2-stage rotary compressor provides subfreezing temperatures.

When the depression period set in, the railroads were beset by virtual stagnation of long-range passenger travel which, unfortunately, coincided with a marked curtailment in freight shipments. Herculean efforts were essential if they were to weather the storm. To the credit of railway management it should be recorded that the greatest betterments in both freight and passenger service in many decades were made during the darkest financial years the United States has ever experienced. Diesel-powered streamlined trains, costing hundreds of thousands of dollars each, greatly speeded up the running time in many parts of the country and proved immensely popular from the start. Without the accompaniment of air conditioning, however, it is doubtful if they would have been so successful.

Study was given to air-conditioned railway cars in 1924, but the first demonstration was not made until 1928. The first successful application was in 1929 on a dining car of the Baltimore & Ohio Railroad. Installations by the Sante Fe, Chicago & North Western, and the Missouri, Kansas & Texas lines followed closely. Those early efforts all involved mechanical-refrigeration plants. Ammonia or methyl chloride was the refrigerant, and the compressor that handled it was in each case driven by a motor that obtained its power from a generator belted to an axle of the car. Once the practicability of comfort-cooling was proved, the demand for it increased steadily. During the first few years little attempt was made to equip other than dining and sleeping cars: the air-conditioned coach did not come along until fairly recently. At first, existing cars were suitably altered; but nowadays the equipment is included in most new cars. The cost per car was about $4,000 in the beginning: today it averages around that figure, although in the interim it has mounted to as high as $8,000 in individual cases.

Although the first few cars carried mechanical refrigerating plants, ice was the predominating cooling medium in those that followed. The latter was more or less of an expedient, as the shortcomings of ice-cooling were obvious. Reicing necessitated relatively frequent stops and attendant time delays, with high labor charges and considerable waste owing to the melting of stocks that had to be maintained at way stations. The "readiness-to-serve" factor was low; and it was generally recognized that some sort of mechanical equipment would have to be provided to give really satisfactory service. This led to the development of various types of axle- or motor-driven compression systems and also of steam-jet vacuum refrigerating plants. All these, however, imposed penalties on the locomotive that had not been anticipated.

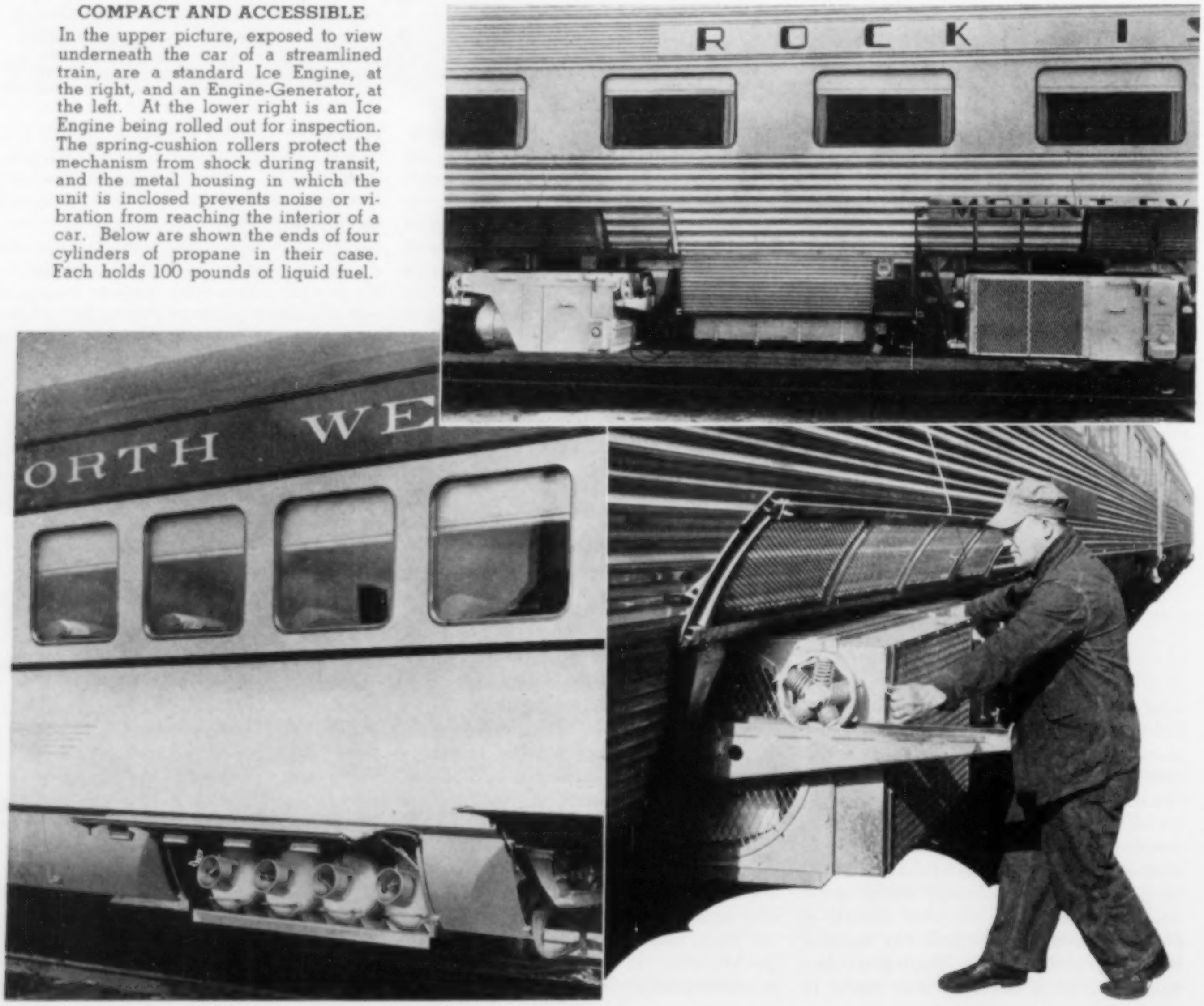
Regardless of the system, the load demands ranged from 10 to 30 hp. per car. To accept it and still maintain fast schedules meant reducing the number of cars per train, with consequent loss of passenger revenue. It was apparent that this parasitic load on the locomotive could be eliminated only by providing the cooling equipment with power from an independent source. This arrangement would have an added advantage: the unit could be operated at any time and anywhere, regardless of whether the train was moving or whether the locomotive was coupled to it. Several efforts were made to develop a self-contained plant of this type. These took the form of gasoline-engine-driven compression systems; but they were not successful, and railway engineering staffs became prejudiced against them.

In the face of this situation, the Waukesha Motor Company set out to build an independent system that would solve the problem, and in 1935 introduced its Railway Ice Engine. This is an automatically controlled, light-weight mechanical refrigeration unit that functions uniformly whether a car is in motion or standing. As it has its own source of power it is unaffected by the speed of the train, as is the case with the axle-driven system. The principal elements in the standard machine are a 20-hp., 4-cylinder, gas-fueled, internal-combustion engine; a 4-cylinder, heavy-duty, air-cooled, reciprocating-type refrigerant compressor; and an air-cooled refrigerant condenser. All are surrounded by sound-absorbing panels. This compact package refrigerating plant is mounted on cushion-spring wheels to enable rolling it under a car on tracks secured to the underframe. The wheels not only absorb shock but also permit rolling the Ice Engine out from under the car like a file drawer, thereby making it accessible almost immediately for inspection or servicing. Thermostatic controls within the car stop or start the engine automatically and regulate its speed according to the cooling demand.

The engine fuel is propane and is drawn from steel cylinders mounted in a carrier beneath the car. It is under sufficient pressure to keep it in liquid form, which makes it possible to store 100 pounds of it in each cylinder. The contents of one cylinder will operate the Ice Engine continuously for twenty hours; and the standard installation of three is enough for a run from Chicago to the Pacific Coast during the hottest weather of the year. Propane has an octane rating of 125, and this permits the use of an engine with a compression ratio of 8.8 to 1, or one much higher than that of an engine fueled with gasoline. Combustion is complete, with no resultant exhaust fumes; and as the propane is delivered to the engine in the form of a dry gas, formation of carbon deposits and dilution of crankcase oil are reduced to a minimum. In consequence, the engine can be operated for as much as 750 hours without changing the oil. This is equivalent to running an automobile 22,500 miles at an average speed of 30 miles an hour. As an indication of the economy and efficiency of propane, it should be stated that the cooling effect of 100 pounds of it in the Ice Engine is equal to that obtained by melting 10,000 pounds of ice. In other words, the normal 300-pound store of propane carried on a car will provide as much refrigeration as 15 tons of ice. The entire equipment involved, including the fuel and fuel tanks, weighs only 2,770 pounds.

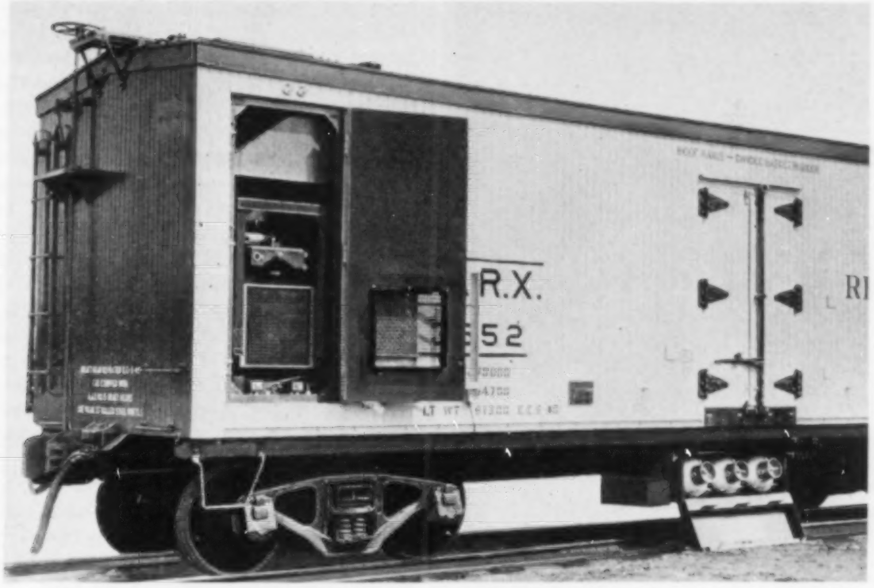
Because of the failures of previous units of this type and the knowledge that service conditions would be severe, the Waukesha system was designed with great care. It was known that it would have to operate dependably at car speeds of from 0 to 120 miles an hour in temperatures ranging, in some instances on single runs, from freezing or below in the mountains to 120°F. or higher in desert regions. It would be subjected not only to the highly abrasive action of dust and sand but to the freezing and clogging action of snow. The latter is a particularly severe condition because the unit must be left partly open to assure a flow of air through the engine radiator and refrigerant condenser even though it may be towed many miles while not functioning. It was foreseen that these and many other widely varying conditions would impose serious lubrication problems.

Waukesha engineers consequently determined, as they have expressed it, to put into the unit all the quality they could. The engine was made of ample size and for a speed to carry the load at all times. To obtain a satisfactory compressor, they called into consultation engineers of Ingersoll-Rand Company, which had for many years been producing a line of small air-cooled compressors known as the Type 30. The two staffs collaborated in modifying this machine so that it would effectively handle Freon refrigerant. One of the principal problems involved was that of developing a positive seal, as Freon gas is much harder to confine than air. It is especially difficult to prevent its escape when the compressor is not operating;



COMPACT AND ACCESSIBLE

In the upper picture, exposed to view underneath the car of a streamlined train, are a standard Ice Engine, at the right, and an Engine-Generator, at the left. At the lower right is an Ice Engine being rolled out for inspection. The spring-cushion rollers protect the mechanism from shock during transit, and the metal housing in which the unit is inclosed prevents noise or vibration from reaching the interior of a car. Below are shown the ends of four cylinders of propane in their case. Each holds 100 pounds of liquid fuel.



AN ICELESS REFRIGERATOR CAR

This picture shows the first experimental installation of a Waukesha Ice Engine in this service. The use of mechanical equipment will eliminate stops for icing. Tests revealed that there was difficulty in disposing of the generated heat when the unit was placed inside the car, so it is being mounted underneath, as in passenger service. The three propane cylinders are seen at the lower right.

and most seal failures occur at that time. The conservation of Freon is important from both an operating and an economy standpoint because it costs about 50 cents a pound and is now hard to obtain.

The desired end was achieved by designing a compressor drive pulley and flywheel that are carried entirely on the compressor housing and revolve on large ball bearings. The compressor crankshaft is driven by a flexible fabric disk that connects it with the pulley. This eliminates any pull on the crankshaft by the driving belt, and, as a result, there can be no deflection of the shaft whether it is at rest or in motion. The seal itself consists of a hard-bronze ring floating in Duprene rubber which is held under compression by a retaining spring and a hardened steel ring.

The engine is fitted with a heavy-duty starter that is operated from the car-lighting battery and has automatic controls that insure positive starting and stopping. It has a governor that is regulated by a speed modulator which, in turn, is actuated by the refrigerant suction pressure that varies with the cooling demand. During the initial stages of cooling, the engine operates at its full speed of 1,200 rpm. As the temperature in the car drops, the engine speed is proportionately reduced down to 600 rpm., the minimum. The compressor runs at half the engine speed, or between 300 and 600 rpm. The engine has a full-pressure oiling system and is equipped with a switch to stop it if lubrication is faulty. The water-cooling system operates at a pressure of 4 pounds, which raises the boiling point of the water to 222°F. An excess-temperature switch protects the engine against overheating from any cause. The compressor has an unloading valve that permits the engine to reach governed speed before the load is applied. There is also a relief valve that prevents the compressor from operating in the event excessively high discharge pressures are attained for any reason. In either case, the Freon gas cycles between the intake and discharge cylinders of the compressor until normal conditions are restored.

As previously stated, three flasks of propane are ordinarily carried. All are connected to a common discharge line and provision is made for emptying them in sequence. This consists of pressure relief valves, one for each flask, set at 30, 20, and 10 pounds per square inch, respectively. The 30-pound valve opens first. When the cylinder that it controls has been emptied, the line pressure drops sufficiently to open the 20-pound valve. After the contents of the second flask have been withdrawn the line pressure again drops, the 10-pound valve opens, and the fuel is taken from the third cylinder. A visible gauge shows the line pressure at all times, so it can be instantly observed which flask is supplying the fuel and whether any are empty and need replacing. A regulator on the discharge line reduces the pressure of the gas to about 4 ounces before it goes to the engine. A valve closes when the flow exceeds 3 cfm., thus providing an automatic shutoff in case the fuel line to the engine is broken. An automatic check valve also stops the discharge of gas from any cylinder if the flexible hose connection is not properly attached to it or not in good order.

Cooling is effected through direct expansion of the Freon; and the system is suitable for use in the usual railway-car installation. After being compressed, the Freon gas is cooled and liquefied in the air-cooled, fin-and-tube-type condensers that are incorporated in the Ice Engine. A heavy, axial-flow-type fan, that is belt-driven from an extension of the main engine shaft, sends a constant current of air through the condensers regardless of the rate or direction of the train movement. From the condensers the liquefied refrigerant flows to a receiver, and thence to an evaporator located inside the car and ordinarily at one end of the clear story that runs longitudinally along the top. The liquid is expanded to a gas in coils, and in so doing absorbs heat from the air that is blown over the coils. This cooled air is distributed throughout the car. Ordinarily, from 2,000 to 2,100 cfm. is circulated. Of this, 75 per cent is usually recirculated while 25 per cent of fresh air is drawn in from the outside through a filter. It joins the stream of recirculated air just before it reaches the evaporator. From the evaporator the Freon gas is returned to the compressor to begin another cycle.

For use in conjunction with the air condensers, Waukesha also makes an evaporative subcooler that increases the effectiveness of the system wherever normal operating temperatures exceed 90°F. Interposed in the line between the air condensers and the evaporator, the subcooler reduces the refrigerant-liquid temperature and head pressure so as to provide an operating condition in the most extreme hot weather equal to or lower than a dry-bulb temperature of 85°. In this apparatus the refrigerant is circulated through a cooling coil on which water is sprayed from a nozzle. The water is circulated by a motor-driven pump. When temperatures are not high enough to require its use, the subcooler water sump can be drained and the unit rendered inoperative.

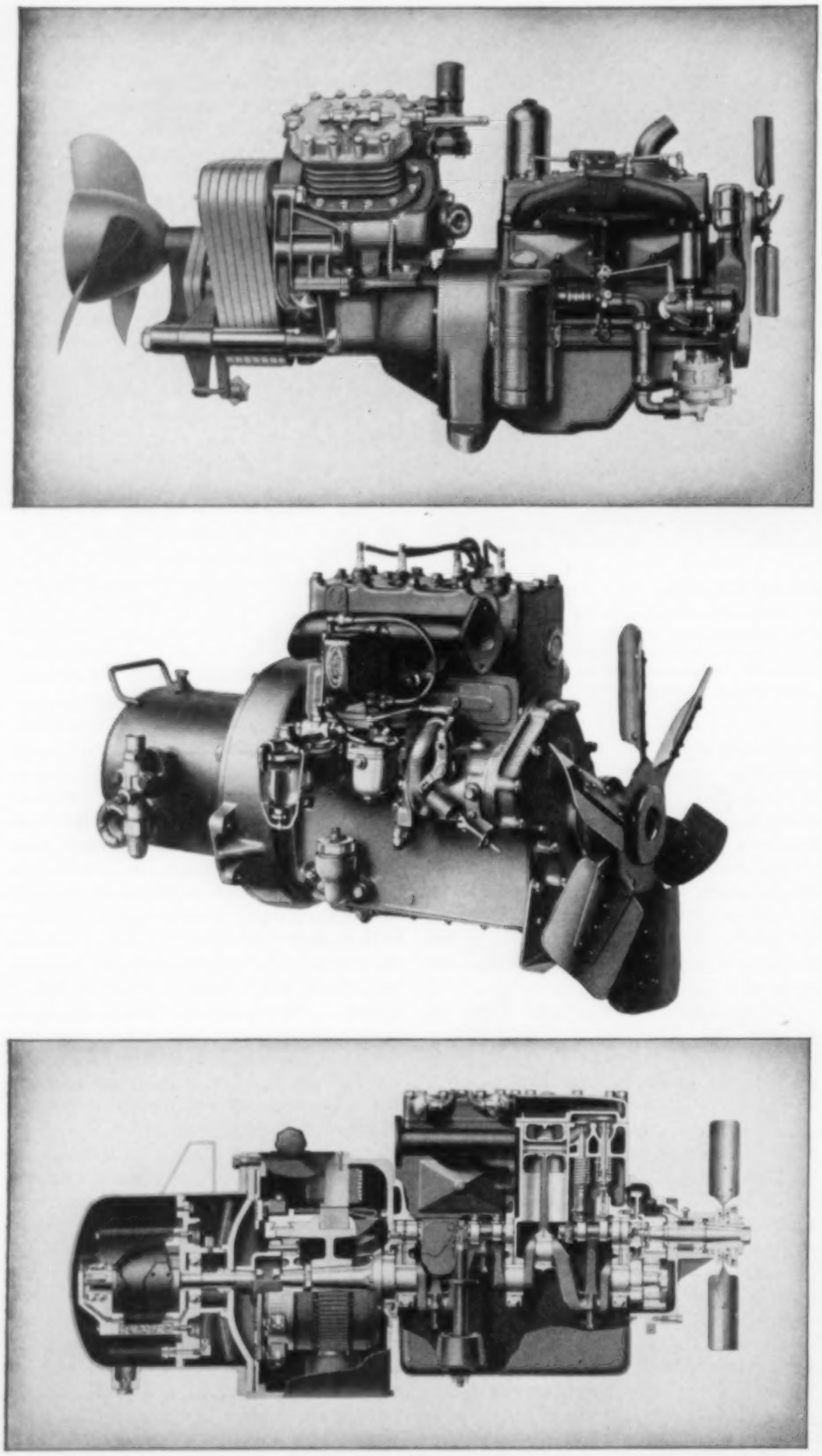
When cars were first air conditioned, the quantity of refrigeration specified as adequate was as low as 4 tons, which is equivalent to the melting of 4 tons of ice in 24 hours. However, this figure has been revised upward, and the standard Waukesha Ice Engine has a capacity of 7 tons. This is sufficient to maintain a comfortable temperature inside a car even when the outside temperature is 100°F. or more. A rule-of-thumb formula for determining the suitable temperature provides for cooling the interior to a point 4° below the mean between 70° and the outside temperature. Thus, if the outside temperature is 100°, the mean is 85°, and the comfort-cooling level is 81°. Applying the same formula, it will be found that when the outside temperature is 80°, the desirable inside temperature will be 71°.

Although it was introduced only six years ago, the Waukesha Ice Engine has been adopted by 24 railroads in North America and is serving more than 1,300 cars. During the past two years more cars have been equipped with it than with any other system. Since 1935, the experience gained has led to improvements and refinements that have greatly increased the reliability of the Ice Engine. This is evidenced by the fact that in the beginning one failure was registered for each 8,500 miles of car operation and twelve service men were employed by the company to keep the units in operating condition. Last year the average car traveled 240,000 miles without a failure, and two service men did all the work. Routine maintenance is, of course, handled by the railroad personnel.

Observing the success of railway-car air conditioning, Greyhound Bus Lines determined to cool its buses and asked the Waukesha Motor Company if it could provide suitable equipment for the purpose. Because the larger buses were already close to the legal permissible weight, and a considerable addition would necessarily reduce the revenue load, the problem was to develop a unit that would be much lighter than that used by the railroads. The smallest reciprocating compressor available for the service weighed 300 pounds, so Ingersoll-Rand engineers were requested to design something smaller. As a result of their collaboration with the Waukesha specialists there emerged a new rotary compressor that weighs only 75 pounds. Waukesha, in turn, designed a light-weight, 4-cylinder gasoline engine that develops from 8 to 14 hp. over a speed range of from 1,000 to 1,800 rpm. The entire assembly weighs only 232 pounds, less than half that of any unit previously available for the service, and its dimensions are such that it can be readily mounted under a bus. Yet it has a refrigerating capacity equal to that of 4 tons of ice.

Both the engine and the compressor are built with great precision, yet they are sturdy enough to withstand the operating conditions with infrequent failures and low maintenance costs. The compressor has ten Nitralloy vanes, and all working parts are inclosed in a 1-piece steel shell that reduces to a minimum the number of joints where leaks might occur. It is bolted to the engine-bell housing and driven through a rubber, bushed pin-type coupling. It is free from vibration and can be operated through a wide range of speeds, thus providing a simple means of capacity control. It unloads automatically when it stops and when it is turning at low speeds, thereby making for easy starting without employing special devices. More than 2,500 motor buses are now equipped with this type of unit. The 4-ton size is for larger vehicles that ordinarily accommodate 37 passengers. A similar unit of 3-ton capacity is used on smaller buses.

Last year Waukesha brought out a 2-ton Ice Engine for trucks. It is generally similar to that built for buses; but to obtain the low temperatures needed to keep



DETAILS OF ICE ENGINES

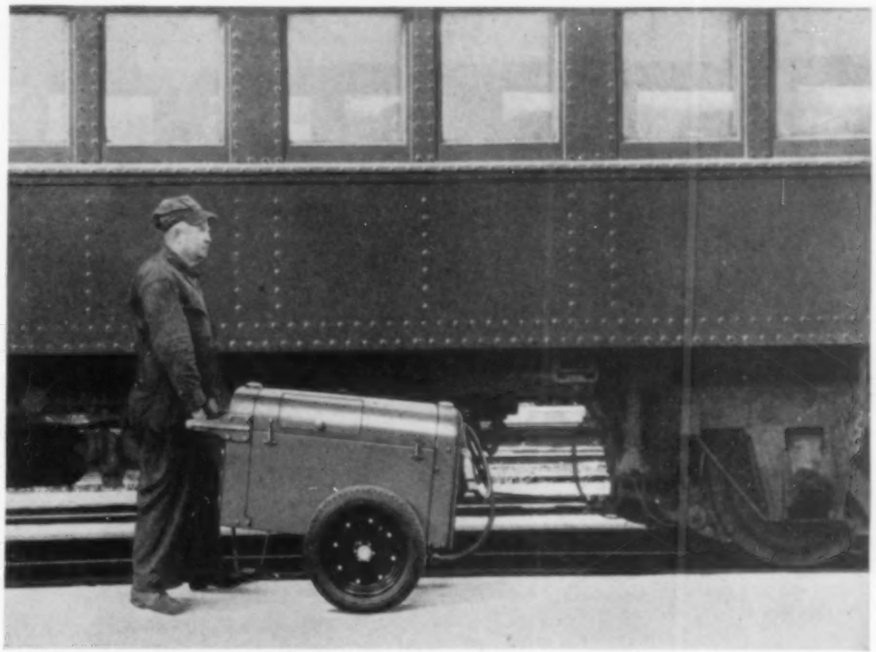
The top view shows a standard 7-ton unit, consisting of a 20-hp., 4-cylinder, propane-fueled engine driving a 4-cylinder, single-stage, air-cooled Freon compressor. The heavy axial-type fan at the left end serves the condensers in which the compressed Freon is cooled. In the center is a 4-ton rotary-compressor unit such as is used on Greyhound buses. At the bottom is a section through one of the special machines designed for mounting beneath certain streamlined cars with center sills where headroom is restricted. To reduce the height of the unit, which is only 22 inches overall when in its steel box housing, the engine spark plugs were placed in horizontal position. The compressor is of the $7\frac{1}{2}$-ton rotary type. The starter motor between the engine and compressor acts as a generator when the engine is running and supplies current for operating auxiliary motors.

meats and other food products in good condition, a 2-stage rotary compressor is utilized. As in the previous cases referred to, it was designed especially for the purpose for which it is employed. The second stage is at the outer end of the machine; and as the first-stage section has been shortened correspondingly, the over-all length is little more than that of the bus unit. The company also offers for this service a fin-and-tube-type evaporator with blower fan. It is designed to maintain the temperature at 15°F. when the outside air is 90°F. The blower is driven by a 12-volt motor. The entire evaporator assembly is housed in a sheet-steel cabinet.

From the experience gained with the bus cooling system, Waukesha was able to design a larger but similar rotary-compressor unit for the streamliners *City of Los Angeles* and *City of San Francisco*. The rotary was required to meet the need for a more compact machine than the standard railroad Ice Engine. The latter has an over-all height of only 31 inches, but the construction of the cars demanded an even shallower unit. The special machine that was developed has an over-all height of but 22 inches. It does more work, however, than the standard reciprocating-type compressor unit, the driving engine having a 24-hp. rating and the compressor a capacity of 7½ tons of refrigeration. The starter motor, which is interposed between the engine and the compressor, serves as a generator when the system is in operation. It has an output of 2 kw., and the current is used to drive the subcooler pump and the fan serving the air condenser, which is located at some distance from the Ice Engine.

The latest application of the Ice Engine is in cooling refrigerated railroad cars. It is still in an experimental stage, although one car so serviced is regularly transporting butter from Iowa to Providence, R.I. The unit is similar to that used on trucks, employing a 10-14 hp. gasoline engine driving a 2-ton rotary-type compressor. The original plan called for mounting the equipment inside the car to prevent vandalism or sabotage, but difficulty was experienced in getting rid of the heat. Accordingly, it was located underneath the car where it is encased in a strong metal housing with grilles.

A companion unit of the Waukesha Ice Engine for railway passenger-car service is the company's Engine-Generator set. The engine is a 20-hp., propane-fueled machine that is identical with the power end of the standard Ice Engine. The 7½-kw., 32-volt generator is of the ball-bearing type, is mechanically ventilated, and fully inclosed. As it is direct driven it can be operated at constant speed, and that speed can be made the most desirable one for efficient output and long life. As is the case with the refrigeration unit, the Engine-Generator functions anywhere regardless of train speed, and therefore has advantages over axle-driven generators.



PORTABLE ENGINE-GENERATOR

This 4-kw. unit is used for charging car batteries in terminals. It obviates switching cars to gain access to station outlets. The machine weighs only 450 pounds.

The electrical load of modern trains is continually mounting, increased current being needed for better illumination and for operating blower fans for air-conditioning systems, as well as heating elements, electric razors, drink mixers and dining-car equipment, radios, etc. The predominating equipment supplying the energy is an axle-driven generator with auxiliary storage batteries that are charged when the train is running. These batteries have to be of ample size to furnish current continuously during long stops or before train-leaving time. In case the car is air conditioned by means of a motor-driven compressor, the storage requirement is especially high. The batteries ordinarily have a capacity of 1,000 ampere-hours, but where an engine-driven generator is employed this can be reduced to 300 or 400 ampere-hours. This not only lowers the investment cost but also decreases the weight that the locomotive must haul.

The Waukesha Engine-Generator is mounted like the Ice Engine on cushioned wheels riding on steel tracks beneath the car and can be readily rolled out for inspection or servicing. The fuel-supply arrangement is the same as that for the Ice Engine, in fact where both units are installed they may draw fuel from a common source of supply. The Engine-Generator is usually set to start at intervals of one hour in summer. When the batteries are amply charged, the engine automatically stops. However, the generator begins to operate anytime the current demand on the batteries exceeds 35 amperes. In winter the generating unit is set to start every fifteen minutes. This is to prevent excessive chilling of the oil, which might interfere with lubrication. The radiator has to be left open to the air to provide for cooling; and just how severe a condition this imposes can be realized by any motorist if he will visualize towing his machine on a cold day at a high rate of speed with the engine not operating.

To supply electric current at terminals to cars equipped with axle-type generators and for miscellaneous other purposes, Waukesha makes a 4-kw. Engine-Generator mounted on a 2-wheel, pneumatic-tired chassis that can be readily moved about by one man. Its use eliminates switching of cars to gain access to electrical outlets.

For each car that is provided with both the Ice Engine and the Engine-Generator, the locomotive is relieved of a load of 40 hp. during six or more months of the year and of at least 20 hp. during the whole year. On trains such as the 15-car *City of Los Angeles*, all of which use both the units mentioned, the total horsepower available on the cars is 600. This is one-tenth the power of the locomotive, all of which can be devoted to tractive effort.

Outstanding among recent installations of the equipment described are those on four new dining cars built for the Southern Pacific Railroad's crack trains, each named *The Lark*, running between San Francisco and Los Angeles. Each diner is of 3-car length and has a kitchen, two butler's pantries, dining compartments, and a coffee shop. Numerous innovations are included, among them a pressure cooker that can cook a bushel of potatoes in four minutes. Each of these cars carries three 7-ton Ice Engines and three 7½-kw. Engine-Generators.

Underground Phone Cable Will Span Country

CABLE-LAYING TRAIN

Left—A procession of tractors moving across flat country. The men at the left walk along beside the equipment to see that all the operations are carried out properly. Bottom left—The lead plow which digs a furrow to a maximum depth of 52 inches and an average depth of 30 inches. Center—Two 7-foot reels of cable mounted at the rear of the second plow. Bottom right—the special cradle at the end of the train that removes empty cable reels from the second plow unit and replaces them with full ones.

TO ALLEVIATE service interruptions caused by wind, sleet, rain, and bird ravages on overhead lines, and to reduce maintenance costs, the Bell Telephone Company is laying an underground telephone cable across the United States. This link in the nation's communications system will be almost invulnerable to the conditions that now put conventional pole-borne lines out of commission. Work on this huge job was started early last spring at the Nebraska-Wyoming state line and is proceeding at several points between Omaha, Neb., and Sacramento, Calif.

The line is first laid out by surveyors and marked at intervals with pairs of stakes placed 20 feet apart laterally. Another row of stakes is set to guide the trenching and cable-laying crew that follows. In addition, stakes are put down every 3,000 feet to mark the points where splicing gangs will later join the various sections into a continuous cable. After the surveyors comes a crew to make arrangements for crossing concrete roads, irrigating ditches, and other structures. In one instance the line passed underneath the doorstep of a home. The cable was buried, the trench across the lawn filled, and the turf replaced so as not to leave a scar.

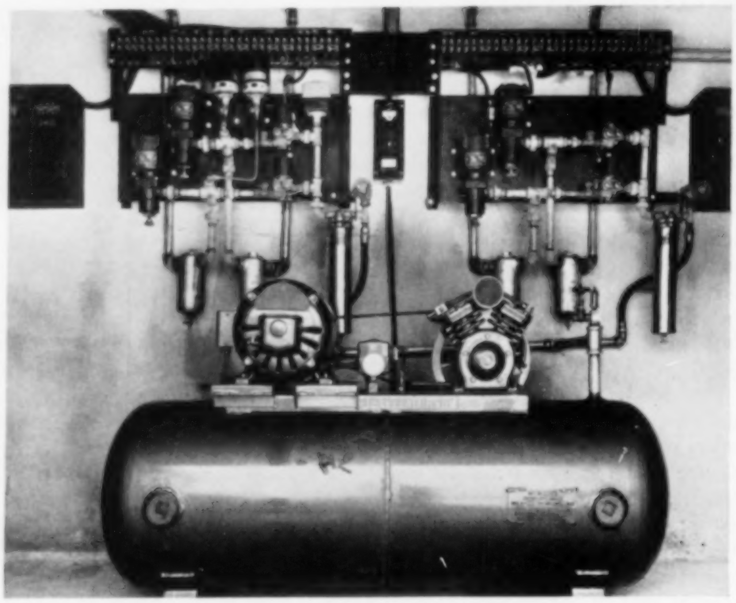
In the plains section, trenching and cable laying are done by a mechanical train that is illustrated in the accompanying pictures. It consists of four diesel-engined tractors, connected one to another by rope lines to make their combined pulling power available when it is needed and to space the operations as desired. The first tractor is a power unit only. It is followed by a plow capable of digging a trench 52 inches deep. After it comes another plow that cleans the trench and lays in it the double cable which is played out from two 7-foot reels mounted at its rear. Next in line is a special mechanism designed for covering up the trench. The last unit, which is without motive power and is towed, is a cradle that is utilized for placing full reels of cable on the second plow when they are required. These reels are trucked in advance and deposited at points where they will be needed.

The average speed of the train is about that of a rapid walk. The daily progress ranges from 7,000 to 24,000 feet, depending upon the terrain, the number of structures to be crossed, etc. The easiest going is in the high, dry plains area. In irrigated sections, trouble is often experienced through tractors sinking into the moist ground. The greatest difficulty will, it is expected, be met when negotiating the salt flats west of Salt Lake City, Utah. In rocky stretches it will be necessary to have recourse to portable air compressors, rock drills, and similar tools for trenching.

Where the line crosses unpaved roads the trench is plowed up as usual and the backfill tamped to leave the surface at its original level. Hard-surfaced roads are not disturbed, a pipe being driven underneath in each case and the cable passed through it. Small streams are plowed through, while larger ones are crossed by dredging a trench which is covered after the cable has been laid in it.

Each of the two cables is about the size of a man's wrist and contains 70 pairs of wires. It is sheathed in lead over which is a layer of asphalt-impregnated jute covered with layers of paper. In addition, the cable that is laid in the plains country is wound with steel tape to foil gophers and other rodents that have shown a liking for less-resistant materials. Each cable section is sealed at both ends and filled with nitrogen gas under pressure to resist the intrusion of moisture. Each pair of wires is color-coded for identification by the splicing crews who may come along weeks after the cable has been laid. After they have been spliced and the joints in the insulation have been sheathed, nitrogen gas is again injected.

Photos, Thomas J. Barbre



AIR COMPRESSOR

For each barrier there is a separate air compressor housed in a metal cabinet such as that shown at the right of the road in the picture below. The machine illustrated is an Ingersoll-Rand Model A air-cooled unit. It is equipped with a pressure switch that starts it when the receiver pressure drops to 100 pounds and stops it when the pressure has been built up to 125 pounds.

Protecting Motorists at Grade Crossings and Drawbridges

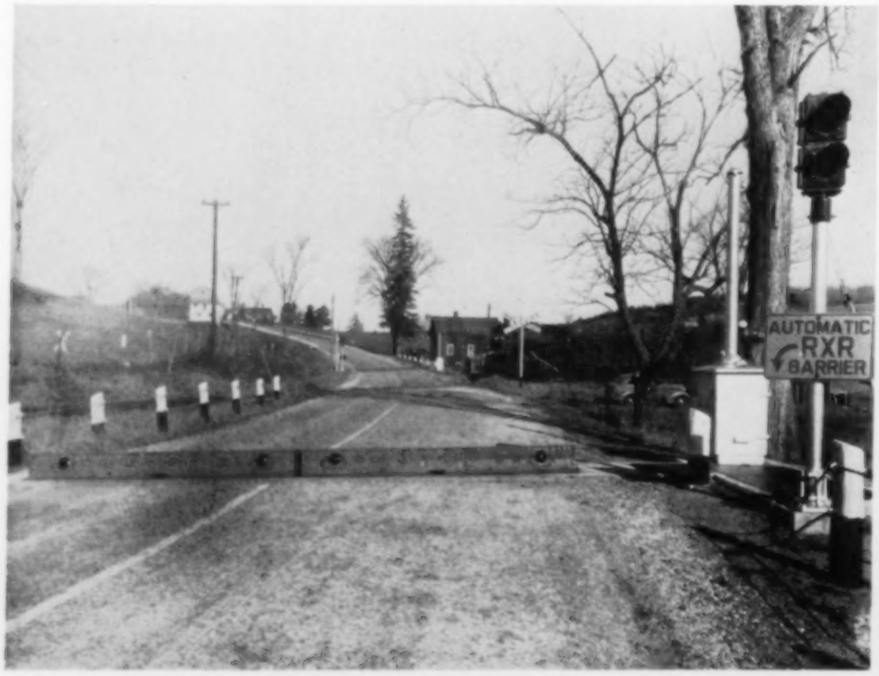
An electro-pneumatic auto-stop barrier is a new safety device for use at highway crossings of railroad tracks and drawbridges. The Public Roads Administration of the Federal Works Agency has approved this type of protection for the motorist, and a number of them has been placed in operation in various parts of the country. The device is made by the Evans Products Company of Detroit, Mich., and is known as the Evans Electro-Pneumatic Auto-Stop.

The barrier sections are 7½-, 10-, or 11½-feet long, depending upon the width of the road, and are set in concrete foundations on both sides of the tracks or drawbridge and usually about 100 feet away from them. Understructures are of structural steel and barrier lids of cast steel. As accompanying pictures show, the lid of each section is outlined with reflector buttons, as are the recessed letters S T O P and R R. The lids are painted yellow and the lettering is black. The barriers will serve to prevent even the most careless driver from crossing the tracks while a train is approaching from either direction. When in the elevated position, the angle of the lid and the contour of its face are such that if a car should strike it the vehicle's horizontal force will be dissipated.

In the case of a grade-crossing installation, when a train enters the track circuit, traffic lights at the sides of the road immediately flash red and remain red until it is safe for cars to proceed. Approximately six seconds after a train has entered the circuit, the barriers rise slowly to a 4-inch or hesitation height. They stay at that level for about ten seconds, while brilliant red lights at the ends of the lids signal warnings. They then rise slowly to their full height of 10¼ inches above the roadway surface, and the red lights burn steadily.

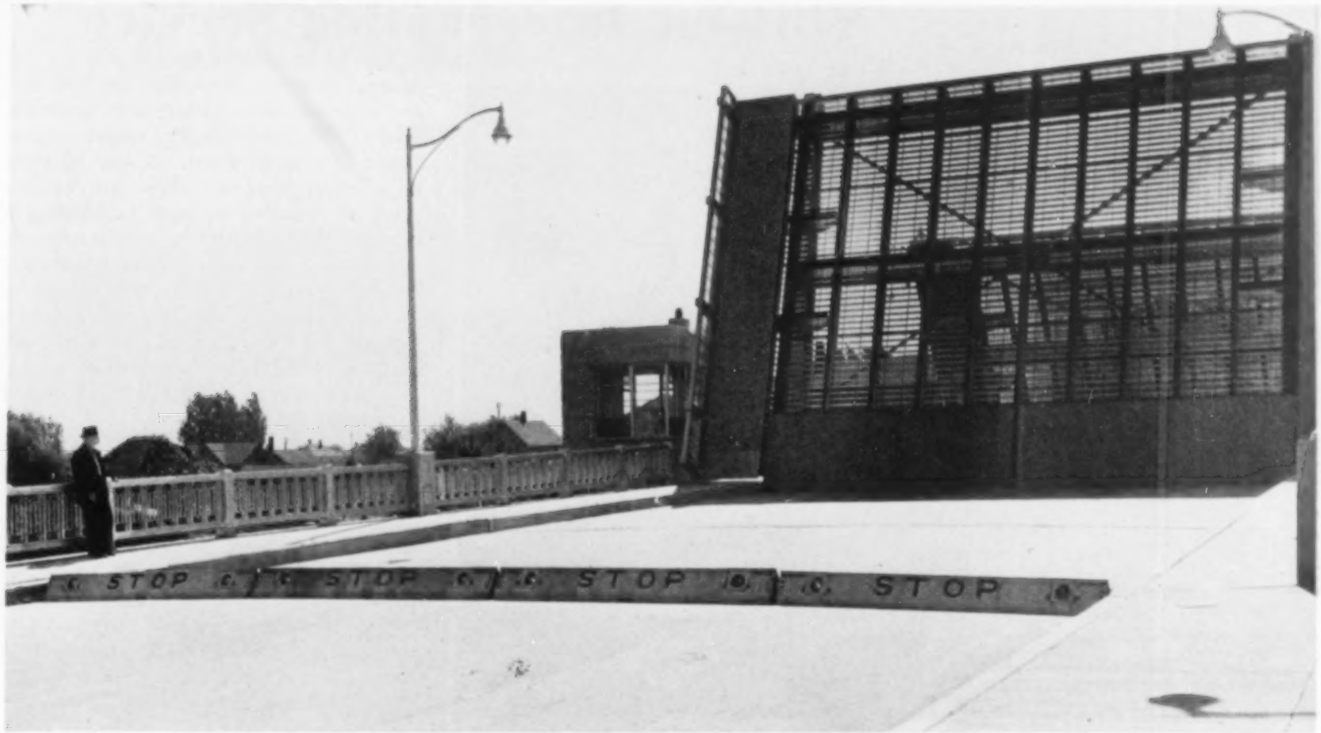
When a train has crossed the highway, the barriers sink into the pavement, allowing traffic to go on. However, if another train has entered the circuit during that time, they will remain at their full height and thus afford protection at crossings where there are double tracks. Hand controllers can be installed at various points along the tracks for use by trainmen. In case a train is standing within the circuit, or switching is being done, it is possible by means of these controls, or by automatic time controls, to cause the lids to recede and the traffic lights to show green so that automobile traffic may proceed. As a barrier disappears, the red lights in its lid and the red traffic lights at the sides of the highway continue to burn until the lid is within 2 inches of the surface of the pavement.

The barrier lids are raised by the action of a 10-inch air cylinder housed underneath each one. The air is piped to each cylinder from the receiver of a compressor housed in a metal case at the side of the road. There is one compressor for each barrier, or two for each installation, and



BARRIER IN RAISED POSITION

An Evans Auto-Stop installed on a 20-foot highway at a railroad crossing near St. Johnsbury, Vt. The 2-section barrier is at its full height of 10¼ inches above the pavement. Within the letter "O" in the sign is a hand-hole cover that can be removed to give access to the air cylinder housed beneath it.



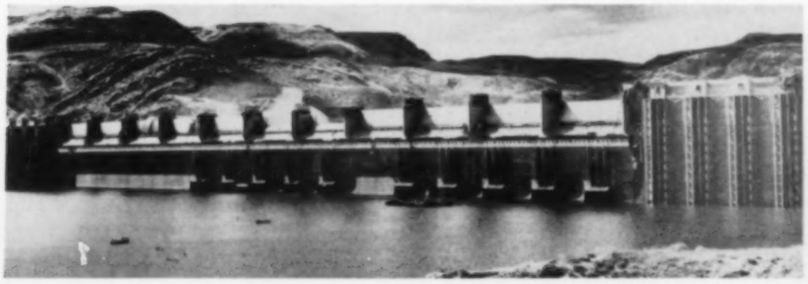
A BARRIER IN OPERATION AT A DRAWBRIDGE

motor-driven, air-cooled units are used. Each is equipped with a pressure switch to start the machine when the receiver pressure drops to 100 pounds and to stop it when the receiver pressure reaches 125 pounds. Adjustable valves on the piston air line permit varying the amount of air admitted and thus control the rate at which the lid rises. When a train has passed beyond the circuit, an exhaust valve in the cylinder air line is opened. As the air escapes, the lid drops by gravity.

The principal power supply is ordinarily obtained from local distribution systems, and 110-volt, 60-cycle, alternating current is used. The power for the electro-pneumatic valves comes from storage batteries and serves as stand-by current for the lights. By this arrangement several complete operations can be made in case of power failure.

In a drawbridge installation, one of which is shown, the barriers are raised to the full protective height of 12 inches by the bridge operator, who can lift and lower independently each of the two sections on opposite sides of the river. The bridge and barriers are interlocked so that the draw cannot be elevated until the barrier sections are at their full height, or vice versa. In general, the drawbridge barriers are the same as those used at grade crossings. Both types are completely concealed, flush with the pavement, when not in service and are operated by compressed air.

Flames Used to Prepare Huge Dam Gates for Painting

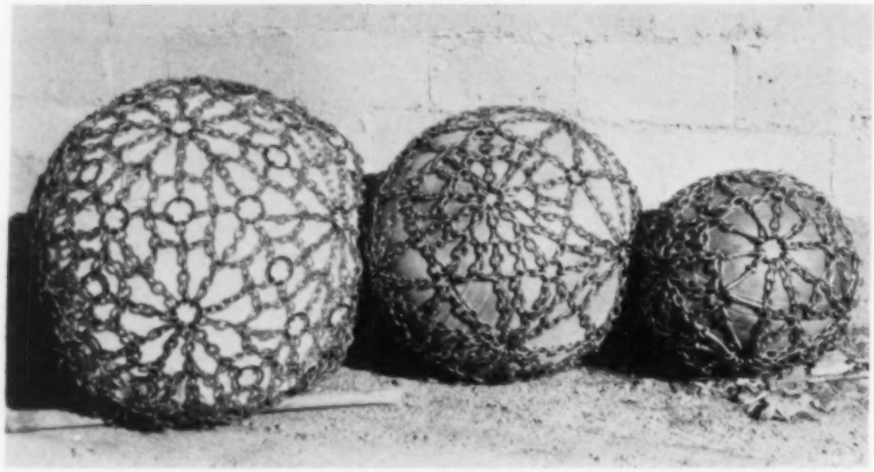


Courtesy, The Linde Air Products Company

DRYING METAL SURFACES BEFORE PAINTING

Before painting the eleven drum gates of the spillway section (above) of Grand Coulee Dam, the surfaces were dehydrated by the application of heat to assure a firm bond between the metal and the paint. The work of drying is called flame-priming, and was done by Oxweld blowpipes, as shown at the right. Two acetylene generators, a 500-pound unit and a 150-pound auxiliary, and a bank of oxygen flasks surmounted by a manifold supplied the necessary gases, which were piped to the points of use. Each gate is 28 feet high and 135 feet long, representing a total area of approximately 200,000 square feet. After drying, the surfaces were wire-brushed and treated with a rust inhibitor before the prime coat of paint was applied.

Cleaning Pipe Without Interrupting Service



EXPANSIBLE BALLS FOR CLEANING PIPE LINES

Rotary Pipe Crawlers made by the Corona Sheet Metal Works for cleaning piping delivering liquids. The largest one is 30 inches in diameter: the others measure 24 and 18 inches, respectively. They are first inflated with air and then filled three-quarters full of water. As a ball is forced through a pipe by the liquid, it carries silt, sand, roots, etc., before it while the chain scrapes scale and tuberculation from the surface. Because of its elasticity, a partially crushed pipe or a 90° bend does not impede its progress. At the top are shown roots removed from a 30-inch pipe line.

FROM all reports, a rotary pipe cleaner on which patents are pending is going to save water companies, especially, many a headache by keeping the lines clean and delivering at capacity. It's a simple contraption that is carried along by the water itself, pushing any obstructions ahead of it and scouring the walls, so it is claimed. As one of our illustrations shows, it's a ball covered with chain mesh that snaps on and off. It is known as the Rotary Pipe Crawler, and there are eleven sizes from 5 to 30 inches in diameter.

The ball is made of a specially compounded rubber and is introduced into a standpipe or manhole in the deflated condition. As it is normally the practice to send the crawler through the pipe twice, it is expanded for the first trip with compressed air so as to give it buoyancy and bring the chain in contact with the top. For the second passage the air is exhausted and the ball is partway filled with water, thus causing it to scrape along the bottom.

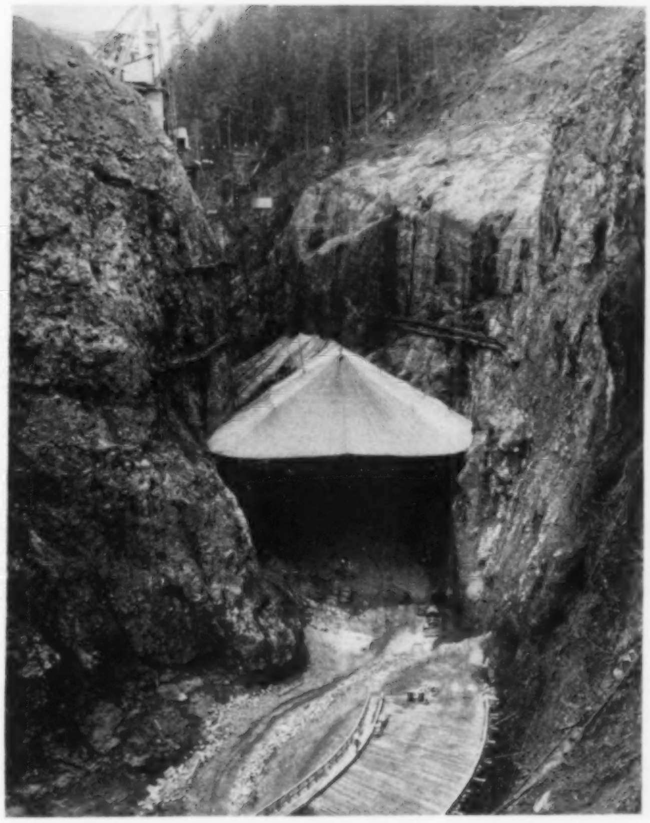
When in position, either in a gravity or a pressure line, the water backs up against the crawler until the head is sufficient to cause it to move. After that the flow carries it along down to the next manhole, where any obstructing material pushed ahead of it is removed. If any obstacle impedes its progress, there are various ways of releasing it, such as sending a second unit, without the chain, after it. If that and other methods are of no avail, then the rubber ball is punctured by means of conventional sewer rods to which a sharp point is attached. So collapsed, it is washed out by the water; and if otherwise in good condition, it is mended for reuse.

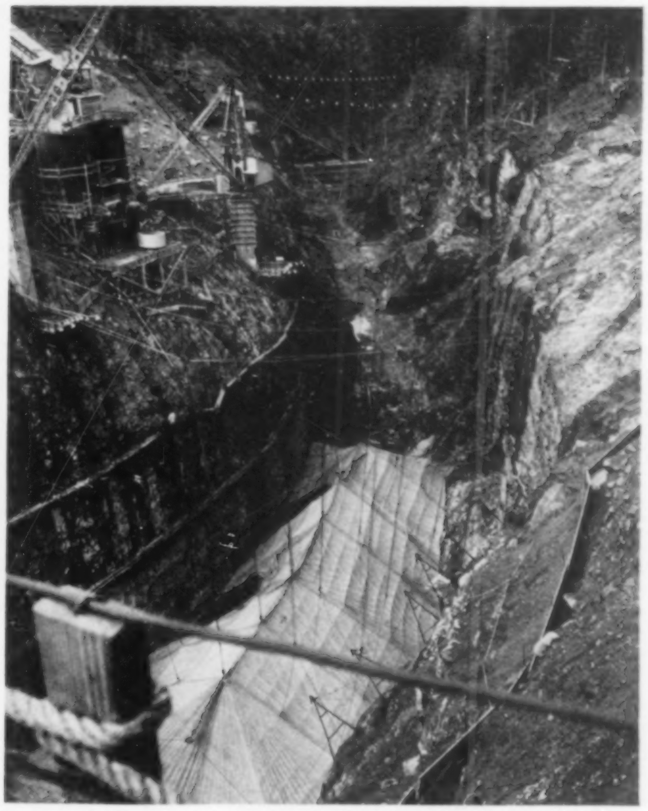
Besides being utilized by water-supply companies, the equipment is finding application in industrial and chemical plants, ore mills, etc., where it is serving to remove deposits or incrustations from wood-stave, lead, and concrete pipes. A case in point is the slime plant of a large copper company where varying chemical solutions are passed through hundreds of feet of pipe lines in the course of a day. One of these has a total length of 997 feet, and is made up of 494 feet of two paralleling 6-inch lines terminating in a 307-foot 8-inch line which, in turn, is connected to a 6-inch line 196 feet long. All are made of lead. A typical analysis of the scale formed in this system shows 83 per cent of calcium sulphate, which is hard and therefore difficult to get rid of.

To clean the piping, a 6-inch crawler is introduced at the head of one of the parallel lines while the head of the companion pipe is closed by means of a blind flange. The solution pump is then started, and the ball forced downhill, the difference in elevation being 29.7 feet. This cleans one of the paralleling sections and the single 6-inch pipe at the end of the intervening 8-inch line. To remove the scale from the latter it is necessary to break two flanges: one at the "Y" connection to insert an 8-inch crawler and another at the end of the 8-inch section to serve as an outlet. That done, a 6-inch ball is introduced in the uncleaned 6-inch pipe and the pump is started after the extreme end of the system has been closed. In this way the 6-inch crawler forces the larger one through the 8-inch line.

Because of the hardness of the scale, the balls are sent through several times. For the first pass they are charged with air at 3 pounds pressure, and this is gradually increased for subsequent trips to 15 pounds. The crawler can be heard as it travels through the piping. If it becomes lodged, tapping on the line usually sets it in motion. Sometimes it is necessary to shut down the pump for a few minutes. Upon starting it again, the sudden surge of the solution will often jar the ball loose. In the plant in question it is now the practice to use the pipe crawlers at least once a month, or before the scale has had time to accumulate.

Building a Dam Under Cover





Courtesy U. S. Army Engineers, Seattle District

"BIG TOP" ON A CONSTRUCTION JOB

Two views of the tent looking upstream during the early stages of the building of Mud Mountain Dam. The picture above shows the silos (upper left) in which the dried core material was stored preparatory to lowering it in buckets to the canyon floor by two stiff-legged derricks. Note the two big openings in the canvas for the passage of the buckets. These hatchways were provided with movable flaps so that they could be closed during rainy weather.

IN OUR July, 1941, issue we had a short article entitled, *Building a Dam Under a "Big Top" to Keep the Earth Fill Dry*. Since its publication we have received additional facts about the undertaking, together with the two striking pictures of the building site as it appeared during the placing of the dried core material under the shelter of the tent. To refresh our memories, Mud Mountain Dam is of the rock-fill type, with a central impervious core of tightly compacted layers of blended sand, gravel, and clay supported by slopes of quarry rock and boulders. It is being reared athwart the White River at a point where it runs through a narrow box-like canyon, and will be the essential unit of a flood-control project that will protect the Puyallup River Valley and the Tacoma industrial region in the State of Washington against floods nearly 50 per cent greater than any so far recorded.

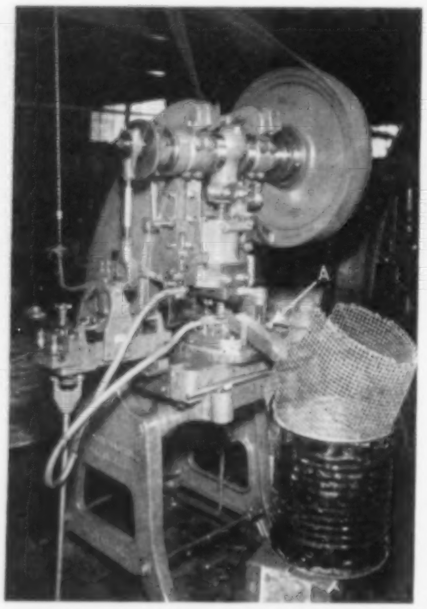
To give the area the desired protection, the reservoir behind the dam will normally be kept empty ready to receive and temporarily to detain flood waters in excess of the capacity of the river channel. When the danger of inundation is past, the impounded water will be gradually released and allowed to flow in the old channel, except where it is by-passed around the barrier by two tunnels about 2,000 feet long. The reservoir will have a capacity of 130,000 acre-feet and when full will form a lake 5½ miles long.

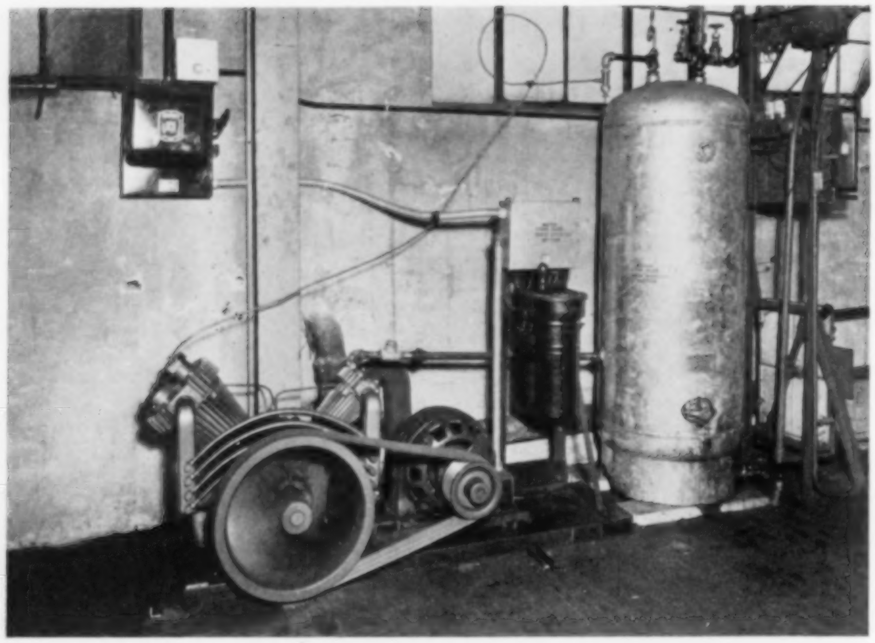
Before entering into the construction of the dam, the core material was passed through three oil-fired, revolving drum driers to reduce its moisture content to that required for maximum compaction and stability. In order to keep it in that condition and to continue operations during periods of heavy rainfall, the core was built up under a tent 300 feet long and varying in width from 105 to 190 feet, the latter at a bend in the canyon. The "big top" called for the use of approximately 55,320 square feet of 10-ounce cloth and weighed, including rigging, around 35,000 pounds.

To support the heavy load, wire cables were strung across the gorge at 50-foot intervals and anchored in the rock walls. Fastened to the cables on approximately 29-foot centers were steel blocks from which hung wire ropes or suspenders that were attached to similar blocks on the upper side of the tent. The eaves of the cover were guyed down to two lines of wire ropes stretched along the canyon walls, and storm cables affixed to the underside of the tent served to counteract updrafts. The lead lines of the suspenders were adjusted by means of hand winches located along the chasm rim, and the entire rigging was arranged so that the elevation of the "big top" could be changed progressively from 950 feet to 1,000 feet and 1,050 feet without the need of lowering the canvas between hoists to make alterations. Built against the canyon walls at these levels were 3½-foot-wide wooden gutters that carried off the rain water from the tent and were also used as platforms by the workmen when raising the canvas.

The project is scheduled for completion on or before November 15, 1942, and is being carried out by the Guy F. Atkinson Company of San Francisco, Calif., under the direct supervision of the U. S. Army Engineers, Seattle District. There is now a bill before Congress to change the name of the structure from Mud Mountain Dam to Isaac I. Stevens Dam in honor of the first territorial governor of the State of Washington.

Quick-Acting Air Ejector for Die Presses





BLAST OF AIR EJECTS WORK

At the left is one of the presses equipped with the pneumatic ejector that was developed by the Philadelphia Steel & Wire Corporation. Air at from 65 to 85 pounds pressure, depending upon the work, is required to blow the finished part clear of the die and into the receiving barrel. The picture was snapped just as a steel cable clamp, indicated at *A*, had been carried partway down the chute under the impulse of the air blast. The wire-mesh guard prevents "shots" from going wide of the mark. Above is the Ingersoll-Rand Type 30 compressor that supplies the necessary air. It is delivered to the receiver at the right and from there piped to the several stamping machines.

METAL-STAMPING or pressing machines are commonly provided with mechanical slides or fingers that serve to eject the finished work from the dies. As the parts handled by them differ widely in size and form, standard automatic presses are built with diverse attachments of this kind to meet the varying requirements. But sometimes a special shape must be stamped that cannot be easily pushed from the die or that may be damaged with the conventional type of ejector. In a plant like the Philadelphia Steel & Wire Corporation, which makes all manner of metal parts for many industrial concerns, problems such as this arise not infrequently and must be dealt with promptly.

Not long ago, when difficulties were encountered with certain work, the company experimented with an air-jet ejector and developed it to a point that justified trying it out under service conditions. The tests were so satisfactory that several of its presses are now equipped with it. One of these machines is shown engaged in turning out steel cable clamps for an electrical concern. The clamps are made of flat strip material and in two stages. At the end of the second operation the finished U-shaped piece is partly locked to the upper die and stripped from it by a fixed collar without damaging it or springing it out of shape.

The press operates at the rate of 98 strokes a minute, and both dies function at each stroke. The pneumatic ejector is so placed that the stream of air issuing from the jet will catch the finished work the moment it is released and deposit it in the receiving barrel without touching the chute down which it would slide if ejected mechanically. Inasmuch as compressed air is required only during a part of the operating cycle, the jet functions intermittently. It is timed to "blow" as soon as a completed clamp is free to travel, and to "shut off" when the top die starts down to stamp another blank that has in the meantime moved into position. This necessitates nice control, which is effected through the medium of a valve gear arrangement attached to the cross head of the press.

Air for the several air ejectors in use in the plant is supplied by a 6&3½x5 Type 30 compressor having a piston displacement of 52 cfm. at 635 rpm. It is a 2-stage air-cooled machine provided with a modern fin-type intercooler and an automatic constant-speed regulator. It is driven by a 10-hp. induction motor.

Staticless Shoes

IN PLANTS where sparks may cause an explosion, such things as nails in shoes are dangerous. This was appreciated long ago, and could be guarded against; but until recently nothing was done to prevent the building up in the human body of static electrical charges that may, as most of us have seen, cause sparks to fly from the finger tips. Working on the theory that such sparks may have been responsible for some of the mysterious explosions in arsenals and chemical plants, an attempt was made to provide a staticless shoe. With the development of electrically conductive rubber, widely used in making power transmission belts, filling-station hose, and casters for hospital beds and equipment, the investigators believed that they had the answer to the problem until they ran up against the workers' likes and dislikes in footwear.

Following that, the U. S. Bureau of Standards, in collaboration with the American Standards Association, the Underwriters' Laboratories, and a well-known college, produced an electrically conductive shoe cement and nontoxic alkaline solutions in which to impregnate leather, cotton linings, and other cellulose shoe findings in order to make them conductive to electricity. As a result of this work there is now available a complete line of shoes that will, it is claimed, prevent the building up in the body of static electricity. It is specified that they be worn with cotton, lisle, or rayon hose.

Conditioned Air for Blast Furnaces

BLAST furnaces are being equipped with air-conditioning systems not, as the layman might suppose, to keep the temperature down but to provide air of uniform moisture content. It has long been recognized that wide fluctuations in humidity affect both the quality of the iron and the quantity produced, and as far back as 1880 attempts were made to regulate the moisture content by passing the air through calcium chloride, sulphuric acid, and other chemicals. Ten years later James Gayley began experimenting with refrigeration, and with the equipment developed proved the correctness of the theory that the removal of water vapor from the blast would not only reduce the amount of coke required per ton of pig iron but would increase the output. A number of installations were made; but they were eventually dismantled because of operating difficulties. But with the advance in the field of air conditioning, blast-furnace operators again interested themselves in refrigeration as a possible solution of the moisture problem.

To appreciate what really is involved, take the case of one of the world's largest blast furnaces—No. 1 Furnace at the Aliquippa Works of the Jones & Laughlin Steel Corporation—that has recently been provided with an up-to-date air-conditioning plant. Air is blown into the furnace at the rate of 80,000 cfm.; and before the present set-up it carried in with it under very humid conditions the equivalent of 30 to 40 tons of water per day. To offset this it was the practice to watch the weather forecast and to change the proportions of the furnace charge accordingly, feeding more coke per ton of iron on hot damp days to take care of the excess moisture. Under the present system the moisture is condensed and removed by drawing it through two sprays of chilled water and eliminator plates, anywhere from 7 to 40 tons of water being taken from the blast daily.

The first modern installation, which is similar to that of Furnace No. 1, was made in 1939 by the Woodward Iron Company. In the meantime the latter has equipped another blast furnace with a refrigerating plant and has placed a contract for the air conditioning of a third. The American Rolling Mill Company, on the other hand, uses a chemical system to get rid of the excess moisture. The Woodward Iron Company claims that air conditioning has increased the pig-iron output of its two furnaces by 10 per cent and reduced the amount of coke required by about 200 pounds per ton of pig iron.

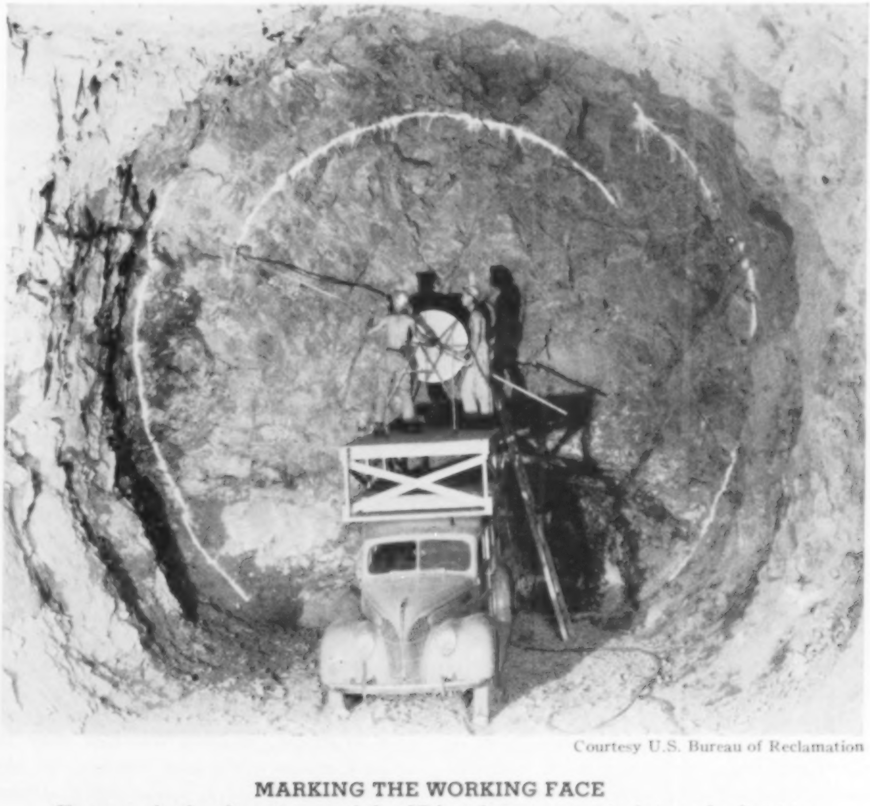
Protractor Helps to Paint Guide Lines on Tunnel Headings

BUILDING of the power house at Parker Dam, in California, involved the driving of four 27-foot-diameter penstock tunnels having an aggregate length of more than 600 feet and consisting in each case of a level section connected by a curve in an inclined plane to a section on a 23 per cent grade. Drilling was done from a ring jumbo which was withdrawn prior to firing each round and run back to the heading after mucking had been completed and guide lines had been painted on the rock face.

Because of the great distance between the invert and the overt, and also because of the absence of supports from which surveying could be done, the marking of guide lines on the headings presented something of a problem. It was satisfactorily solved, says Tom R. Johnson, associate engineer on the Parker Dam power project, by the use of a station wagon with a wooden platform on which rested a pair of A-frames connected by a 6-foot axle made of 1-inch pipe. Adjustable legs permitted movement of the axle in the vertical plane, while horizontal movement necessitated shifting the entire framework. By the aid of a transit, the axle could thus be placed coincident with the tunnel center line.

Mounted on the axle so that it could slide back and forth was a 3-foot-diameter plywood protractor that was held in position by a hand setscrew. It carried an 18-foot-long pole to the outer end of which was attached an ordinary spray gun that could be started and stopped at will from the platform by pulling a wire tied to the trigger. Compressed air for its operation was taken from the regular tunnel supply line and fed through a small welding hose. Tacked to the pole was a metal tape for the purpose of measuring the distance from the center of the protractor to the gun. The nozzle of the latter was guarded by a tube of 1-inch diameter to confine the spray and to assure a uniform line. Two men were required for the job.

By moving the protractor along the axle it was possible to compensate for variations in the rock face and also to provide an azimuth normal to the center line of the tunnel. In sections where the invert was too low to place the axle on the center line, polar coördinates were computed and the radial distance of the gun varied accordingly. With this set-up there was no difficulty in painting guide lines on a constant radius and to do the work in from one-half to two-thirds less time than formerly.



Courtesy U.S. Bureau of Reclamation

MARKING THE WORKING FACE

Close-up of a heading in one of the 27-foot-diameter penstock tunnels showing how the guide lines for the drill runners were painted. After the frame and protractor had been properly oriented in relation to the center line of the tunnel and the rock face, one operator swung the pole and worked the trigger of the spray gun while the other one read the measuring tape and kept the gun at the right distance from the center line.

Editorial

Roadbuilding Soldiers

MODERN tactics in land warfare, as exemplified in Europe, place increased emphasis upon engineering. As pointed out by Col. Stuart G. Godfrey in a recent issue of *Civil Engineering*, men and supplies are of no value in winning battles unless they can be moved to vital points at precisely the right times. This movement depends primarily upon the construction, maintenance, and repair of roads and bridges. Roads were so vital to military operations in Caesar's day that he built hundreds of miles of them that are still usable. They have played important parts in every war since then. In the first World War, highway construction in France was considered so necessary by the British that they specified that every fifth truck moving toward the front lines should carry roadbuilding materials. It is reported that the French used 17,000,000 tons of such materials during that conflict; and the engineers of our own A.E.F. placed more than 300,000 tons of them before the Armistice was signed.

The extensive use of motorized equipment and the high speed of transport that are essential to the surprise attacks of the so-called Blitzkrieg warfare place even greater emphasis on adequate highways. It is claimed that the incredibly fast progress made by the Germans in their Polish invasion was attributable to the efficiency with which their engineer troops repaired roads over which the motorized columns had to pass. In another theater of war, China's lifeline, the Burma Road, continues to function only because thousands of coolies are available immediately to repair the damage that is continually being done by Japanese bombers.

According to the meager information obtainable concerning the organization of the German army, every company in an engineer battalion is equipped with two portable air compressors and a rather complete complement of pneumatic tools such as rock drills, pavement breakers, picks, riveting and caulking hammers, etc. Mechanical saws also are important adjuncts, but, for some unknown reason, the Germans drive theirs with internal combustion engines instead of with compressed air. The compressors are of the trailer type, which is apparently favored over the truck-mounted kind.

In the organization of our own Defense Army careful attention is being given to the formation and training of engineer units. Since the World War, our peacetime army has included only about 5,000 engineer troops, and they have had little specialized experience in roadbuilding. Already, however, their number has been increased to 75,000, and it is announced that they are fully equipped. These units are receiving practical experience in building and maintaining roads in camp areas as well as through the medium of field maneuvers.

A normal field army includes nine division engineer battalions, six corps engineer regiments, three general service regiments, six labor battalions, and two dump-truck companies. All these units have varying amounts of roadbuilding equipment, which totals 129 air compressors, 147 bulldozers, 24 gasoline shovels of ⅜-and½-cubic-yard capacities, 18 motorized road graders, and 1,398 dump trucks. The trucks are used to haul the troops when they are on the move. In addition to the equipment mentioned, special machinery is being stocked in army depots for issue to troops as needed. In this category are portable rock-crushing plants, road rollers, bituminous mixers, scrapers, spreaders, etc.

Among the personnel of both officers and draftees are hundreds of men who are experienced in highway building, and many of these are assigned to engineer units. Their training will include the laying out of roads, in which they will have the assistance of aircraft, and the application to military use of various road techniques developed in highway construction, with special emphasis on the applicability of bituminous materials for the rapid repair of military roads. The Engineer School at Fort Belvoir offers continuing 3-month courses in the operation and care of all types of equipment used.

Already the army in training has made substantial progress, it is reported, and has devised some special roadbuilding methods for use in warfare. Among the innovations is a novel type of corduroy mat consisting of small poles wired together. These can be rolled up for transport and can be spread down quickly in marshy ground to form a roadway that will support the weight of tanks. This ingenious development was made by the 15th Engineer Battalion at Fort Bragg, N. C.

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A "Wild" Tunneling Idea

THE death last month of Wilson S. Kinnear, formerly a leading construction engineer, recalled the fact that he helped make tunneling history in the United States. Mr. Kinnear was in charge of the construction of the Michigan Central Railroad tunnel under the Detroit River between Detroit, Mich., and Windsor, Canada. This was the first large subaqueous bore ever built up in sections on the surface, then sunk in a trench, and joined underwater. The same method was employed in the case of the new Bankhead Tunnel at Mobile, Ala., which was opened to traffic early this year and which was described in our October, 1940, issue.

The idea of tunneling underwater by the "build-and-sink" method was suggested as early as 1854, when an engineer named Miller published a pamphlet bearing the title, *Miller's Submarine Avenue*. He suggested laying a huge pipelike shell on the bed of a river or bay and anchoring it to keep it down. Most of his contemporary engineers pooh-poohed the scheme; and the eminent Drinker referred to it as "a type of the many wild designs put forth." No one ventured to try out the method until 1893, when a 9-foot sewer was successfully built under Boston Harbor.

At about the beginning of the present century, the Michigan Central Railroad began actively to consider the construction of a bridge or tunnel across the Detroit River to supplant ferry service for transporting passengers and freight. Its competitor, the Grand Trunk Railroad, had built the Sarnia Tunnel under the St. Clair River by the conventional shield method in 1888. Finally a tunnel was decided upon, and the choice of the procedure to be followed in constructing it was left up to an advisory engineering board composed of W. J. Wilgus, chief engineer of the New York Central Railroad; Howard A. Carson, chief engineer of the Boston Transit Commission; and Mr. Kinnear, who was then general manager of the Michigan Central, after having served as its chief engineer. It was specified that Mr. Kinnear was to supervise the construction. The board was open-minded and permitted contractors to bid on alternate plans, one of which called for building sections in the dry, floating them into position, sinking them in a trench, and joining them underwater. This design was suggested by Mr. Carson.

When the bids were studied, it was found that the "build-and-sink" plan would cost the least, and it was decided to adopt it. The contractor, Butler Brothers Construction Company, began work in 1906, with many engineers skeptical over the outcome. However, the work went along without serious trouble; and one by one the ten double-tube sections, each 262 feet long, were lodged on the bottom and connected. On September 10, 1910, the first freight train ran through the bore, and in the following month regular train service was routed through it. The tunnel has been in use ever since. Including land approaches, it is about 1.3 miles long. It cost approximately $7,000,000.

Electric Silver-Soldering Tool

ELECTRIC equipment for brazing with silver has been announced by the Ideal Commutator Dresser Company. The unit is mounted on wheels for shop or field use and consists of a cabinet in which the heating "iron," a transformer, and a foot switch, together with the necessary supplies, are compactly housed. When in service, the turned-back cover forms a shelf on which the flux, solder, etc., can be placed within convenient reach of the operator. The brazer is in the shape of pliers and works on the same principle as the company's Thermo-Grip soft-soldering tools.

The part to be brazed is held in the plier jaws and quickly brought to the desired temperature, and the heat is controlled by the pedal switch which leaves both hands free for soldering. Holding the work in the pliers closes a secondary circuit and, through the medium of the transformer, reduces the current for the standard unit from 230 volts, 50-60 cycles to 10 volts. A 460-volt, 25-cycle tool is also available. Power is consumed only when the switch is turned on. Large flat carbons are supplied; but these can be filed to meet requirements. The jaw ends of the pliers are removable so that different-shaped ones can be substituted in accordance with the needs of the work.

Big Pipe Cast in India

IN AN article on the Warren Foundry & Pipe Corporation of Phillipsburg, N.J., in our January, 1941, issue, we illustrated and described 96-inch cast-iron pipe and made the statement that it was believed to be the largest ever cast. That this size has been exceeded abroad is disclosed in a letter from the Indian Iron & Steel Company, Ltd., of Calcutta, India. Following is a quotation from the letter:

"We feel that it might be of interest to you to know that the Bengal Iron Company, Limited, located at Kulti, about 130 miles from Calcutta, and which was acquired by this company a few years ago, manufactured cast-iron pipes of 102-inch bore as far back as 1929. The principal dimensions of these pipes were: bore, 102 inches; length, 9 feet; outside diameter of flanges, 113 inches; wall thickness, 2 inches. Each section weighed 9½ tons, and the pipes were tested with water pressure under 400 feet of head.

"The flanges were faced, drilled, and pin-bitted. A total of 16 pipes was made, and all were pit cast and conveyed a distance of 1,124 miles without any difficulty from the works to a site for the Mettur Cauvery Water Scheme. They have been in use for 12 years, during which period they have given every satisfaction."

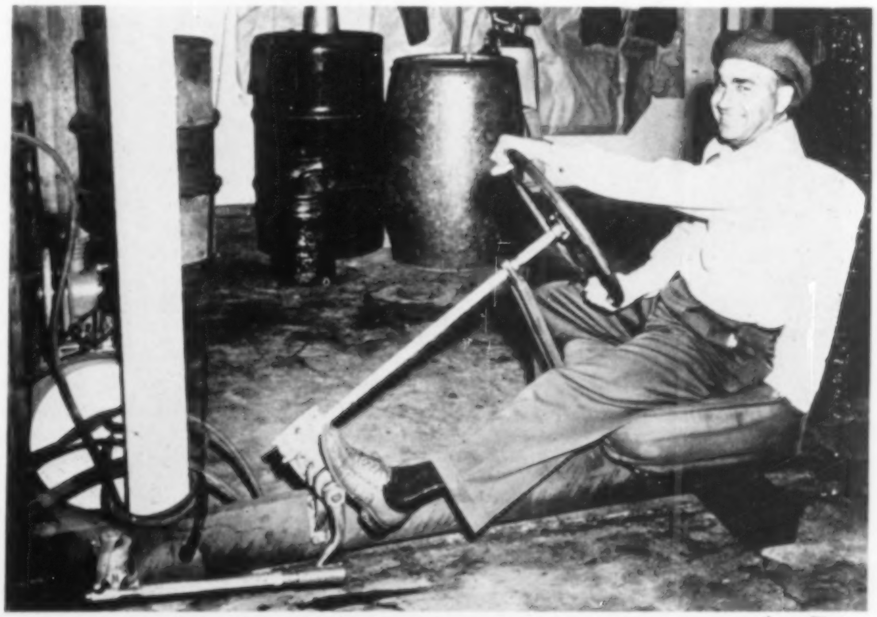
H. C. Bellinger Dies

HERMAN C. BELLINGER, who retired at the close of last year after 54 years of activity in the mining industry, died at Spokane, Wash., on July 27, aged 74 years. He served as a vice-president of the Chile Exploration Company for twenty years and as a vice-president of the Chile Copper Company and president of the Chile Steamship Company for seventeen years.

A native of Germany, Mr. Bellinger was brought to the United States when a young boy. He was educated by his father, who was a graduate in chemistry of the famous mining school at Freiberg, Germany, and in 1886 began a career with various copper- and lead-mining companies which he served in capacities ranging from chemist to general manager.

He was general manager of the Great Cobar, Ltd., in Australia from 1909 until 1914, during which period he served a term as president of the Australasian Institute of Mining and Metallurgy. In 1916, two years after joining the consulting engineering staff of Guggenheim Brothers in New York, he was made general manager of the Chile Exploration Company, which the Guggenheims then owned. After spending six years in Chile, he was called back to New York to become a vice-president of the company, which was the operating subsidiary of the Chile Copper Company. When the Anaconda Copper Mining Company acquired control of the Chile Copper Company in 1923, Mr. Bellinger became one of its vice-presidents and also was retained as a vice-president of the exploration company. Later in the same year he was made president of the Chile Steamship Company. He filled all these positions until his retirement.

For the part he played in improving the welfare of the people of Chile, that republic awarded him the Order of Merit, grade of Knight Commander, in 1935. He was a member of the American Institute of Mining and Metallurgical Engineers and of the Mining and Metallurgical Society of America. He had been a director of the Grace National Bank, of New York, for a number of years. Mr. Bellinger is survived by his widow, one son, and a daughter.



Acme Photo

HOW AN AUTOMOBILE RACER TRAINS

Driving an automobile at high speed requires physical endurance, and muscles must be in condition to withstand the strain placed upon them. To simulate the motion of a car traveling 125 miles an hour, "Cotton" Henning, a mechanic, rigged up the device illustrated. A compressed-air cylinder jostles and jerks the driver violently and, in holding to the wheel, his arm and wrist muscles get a severe workout that hardens them for actual driving. The picture shows Chet Miller, veteran Detroit driver, in the seat during the training period for the annual 500-mile race at Indianapolis last Memorial Day.

Industrial Notes

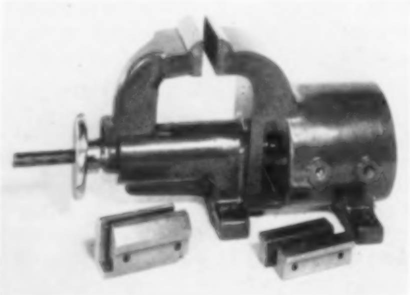
Graton & Knight Company, manufacturers of Research Leather Belting, publish a data book that enters exhaustively into the subject of leather belting in relation to short-center motor drive. It comes in two editions, one dealing with the Rockwood pivoted motor base and the other with the American tension-controlled motor base. The first 40 pages of both books are alike, and include information, tables, and formulas by which the base and the length, width, and thickness of belt suitable for a motor of given horse power can be easily determined. Twenty-two pages are given over to drive-selection tables embracing motor pulleys ranging from 3 to 30 inches in diameter and motors from 1 to 150 hp. The remaining pages are devoted to typical installation views of and details about the American or the Rockwood base. The data book should prove a valuable addition to any power engineer's shelf, and can be obtained upon request from Graton & Knight Company, 356 Franklin Street, Worcester, Mass. Letters should specify the type of motor drive in which the writers are most interested.

Ingersoll-Rand Company has increased its line of air-operated impact wrenches by a light-weight model—Size 504—that is adapted for assembly work especially where space is limited. It weighs only 4 pounds; has a small-diameter nose; is 9⅛ inches long, not including the chuck; and has a form-fitting pistol grip that makes for ease of handling. It is designed to apply and to remove nuts up to and including ⅜ inch in size (bolt size). The tool is built on the Pott impact-wrench principle by which the impact of steel on steel is localized and the shock is not transmitted to any other part of the tool. The company manufactures five sizes of impact wrenches, including the new model, which are illustrated and described in detail in Bulletin 2758 that can be obtained from its New York office at 11 Broadway or any of its branches.

FOR CLOSE-QUARTER WORK

The new 4-pound air-operated impact wrench running down cap screws in an automobile plant.

Fastmatic is the name of a new mechanical vise that is designed to meet the requirements of quantity production. The jaws are closed and opened by means of a piston operating in a cylinder and connected directly to the sliding jaw member. Power is exerted by oil or air under pressure. The latter is taken from the regular shop line and ranges from 80 to 100 pounds pressure per square inch. The piston travel does not exceed 1 inch, regardless of the jaw spacing, and is controlled by either a hand or foot valve, the latter being preferable because it leaves both hands free to attend to the vise. It is suitable for both bench and machine work and is available in a number of sizes and with a variety of soft or hard and straight or formed jaws.

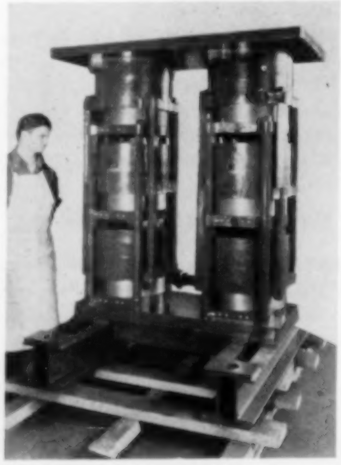


The Buick Motor Division of the General Motors Corporation has a Byproducts Department that is concerned only with the elimination of waste, including everything from paper cartons, sheet asbestos, lumber, and metal scrap to damaged or outmoded structural parts, motors, etc. It salvages annually a total of 244,000,000 pounds of metals and materials worth approximately $2,000,000.

Among the innovations in the new International Business Machines Corporation plant at Endicott, N.Y., there are two systems for circulating cutting oil and grinding coolant. The fluids are drawn from large reservoirs in the basement of the building and are supplied directly to the work during the machining processes. After use they are purified by settling, filtering, and centrifugal separation of the metal particles before being recirculated. One line handles 660 gallons of cutting oil a minute and the other 330 gallons of coolant. The structure also has a built-in pipe line for compressed air; and the several floors are served by a pneumatic tube that is designed to carry blueprints, small tools, gauges, etc., weighing up to seven pounds. No fewer than 24 conducting and circulating systems are concealed in the walls, floors, and shafts of the plant.

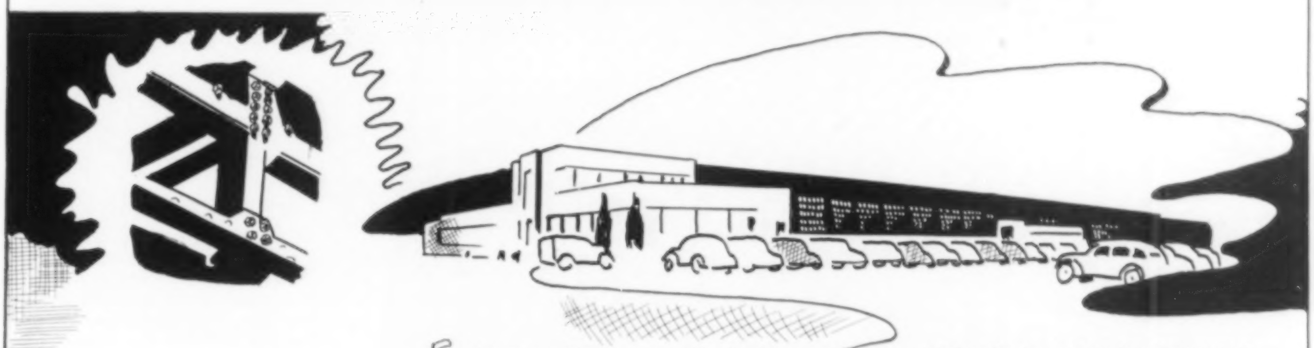
The Goodall Rubber Company, manufacturers of industrial rubber products, has released a new catalogue covering its line of waterproof clothing. In all, 150 items are described and 54 are illustrated. Among the new products shown is a light-weight, low-acid shoe for workers in chemical plants, copper refineries, and other industrial establishments where the floors are always wet and the water contains acids or other chemicals. The footwear also offers protection against falling objects, being provided with a roomy steel box that is said to withstand more than 3,000 pounds pressure. The toe saver is white, so that inspectors can tell at a glance whether the men are properly shod. A free copy of Catalogue 203 can be obtained by writing to the company, 10 South 36th Street, Philadelphia, Pa.

Among the new products announced by the Dayton Rogers Mfg. Co., is a pneumatic die cushion that is designed for extra heavy-duty work. It is known as the Model CC and is available in double and tandem units for ring-holding pressures ranging from 25 to 50 tons on large double- or single-crank presses as well as double-crank, double-throw presses. The die-cushion assembly is provided with a combination air-reducing valve and pressure gauge that automatically regulates the draw-ring holding pressure at all times. The installation usually includes a surge tank of a prescribed size that serves to maintain well-nigh constant pressure throughout the working cycle on the pin pressure pad which, in turn, transmits it to the draw ring on the die or dies. The cylinders are arranged so that the working parts are not brought in contact with the cushion and cannot be damaged by slugs and other loose parts that may drop through the opening in the press bed.

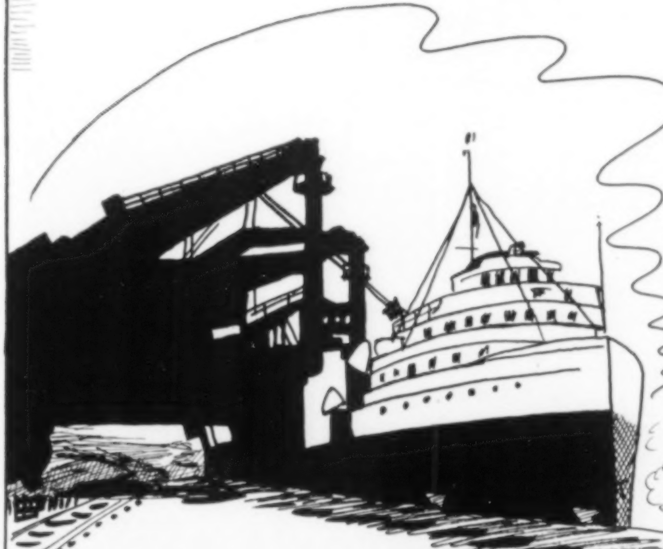


FEATS & FACTS

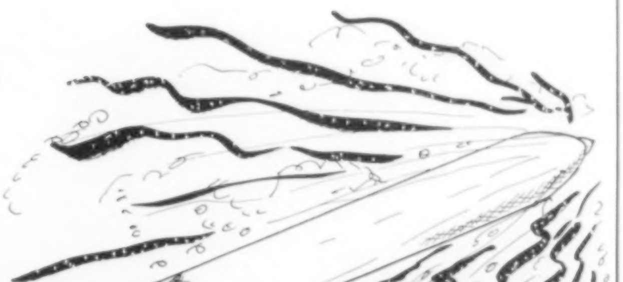
By ROBERT GLUECK



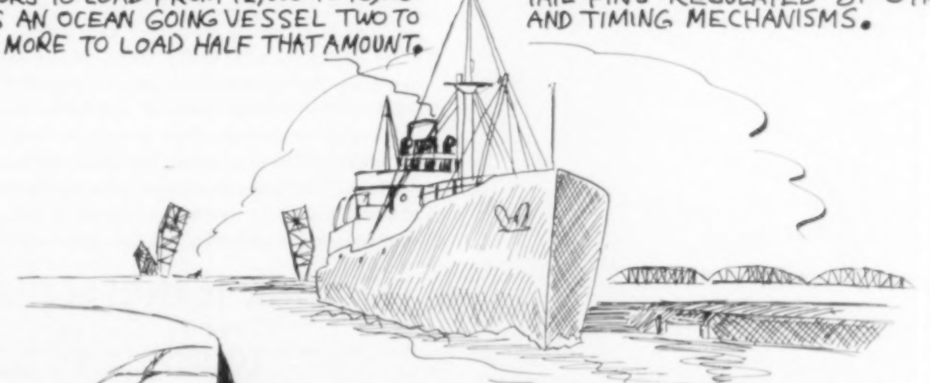
ELASTIC STOP NUTS ARE USED TO ASSEMBLE MANY ARTICLES INCLUDING AIRPLANES, TRUCKS, OIL DERRICKS RAILROAD CARS AND ROCK DRILLS. TO SHOW ITS CONFIDENCE IN ITS PRODUCT THE **E**LASTIC **S**TOP **N**UT **C**ORPORATION USED THE NUTS AND BOLTS INSTEAD OF RIVETS TO FASTEN TOGETHER A PORTION OF ITS NEW FACTORY AT UNION, N.J. IN 1940.



THE RECORD FOR LOADING A GREAT LAKES ORE BOAT IS 12,508 TONS IN 16½ MINUTES. ORDINARILY IT TAKES ONLY THREE HOURS TO LOAD FROM 12,000 TO 13,000 TONS. IT TAKES AN OCEAN GOING VESSEL TWO TO THREE DAYS OR MORE TO LOAD HALF THAT AMOUNT.



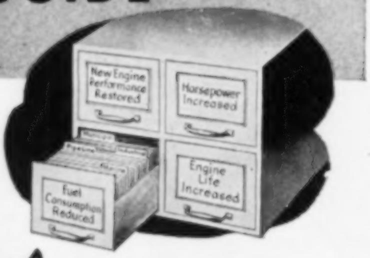
A MODERN TORPEDO COSTS $12,000.00 AND CARRIES 500 POUNDS OF TNT IN ITS 15-FOOT LENGTH AND 21 INCH DIAMETER. IT TRAVELS THROUGH WATER AT 45 MILES PER HOUR AND CAN HIT A TARGET 3 MILES AWAY. SHOT OUT OF ITS TUBE BY COMPRESSED AIR, AN ALCOHOL BURNER INSIDE THE PROJECTILE GENERATES STEAM FOR THE TWO ENGINES WHICH DRIVE THE TORPEDO'S TWO PROPELLERS. ITS COURSE IS CONTROLLED BY VERTICAL AND HORIZONTAL TAIL FINS REGULATED BY GYROSCOPIC AND TIMING MECHANISMS.



THE SOO LOCKS, SAULT STE. MARIE, MICHIGAN, HANDLE IN THEIR EIGHT MONTHS OF ANNUAL OPERATION MORE TONNAGE THAN THE PANAMA AND SUEZ CANALS COMBINED FOR A FULL YEAR!

LET *Experience*☆ BE YOUR GUIDE

TO THE SOLUTION OF YOUR PISTON RING PROBLEMS


New Engine Performance Restored
Horsepower Increased
Fuel Consumption Reduced
Engine Life Increased

☆ **THIS CASE HISTORY** *and the others in this series are typical of the many in our file, supplied by operators of prime movers throughout the country who have found the answer to their ring problems in a change to COOK'S GRAPHITIC IRON PISTON RINGS.*

☆

Prominent Operator Greatly Reduces Fuel and Lubricating Oil Costs . . .

EQUIPMENT

940 H.P. four-cycle Diesel engines.

PROBLEM

High fuel and lubricating oil costs.

CORRECTIVE ACTION

Eliminated loss of compression power that was occurring through the joint openings of the original style rings by installing COOKTITE Sealing Rings along with COOK'S Oil Control Rings.

RESULTS

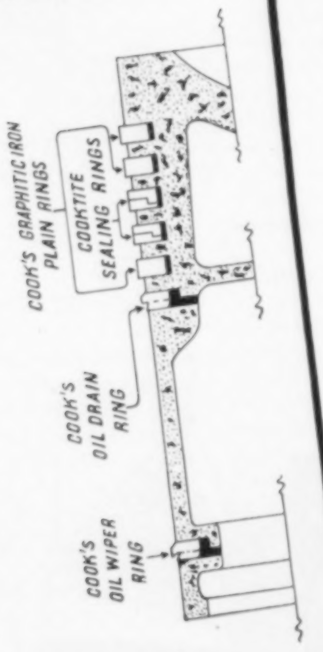
Check-up after 2½ years' operation with COOK'S Rings showed:

1. Fuel oil consumption reduced approximately 12%.
2. Lubricating oil consumption reduced 60%.

SOURCE OF DATA

Superintendent of plant.

* Case History No. 38-2-B.


COOK'S GRAPHITIC IRON PLAIN RINGS
COOKTITE SEALING RINGS
COOK'S OIL DRAIN RING
COOK'S OIL WIPER RING

This is the COOK'S Rings combination that was used.

COOK'S GRAPHITIC IRON *Piston Rings*

"Sealing Since 1888" Pressures

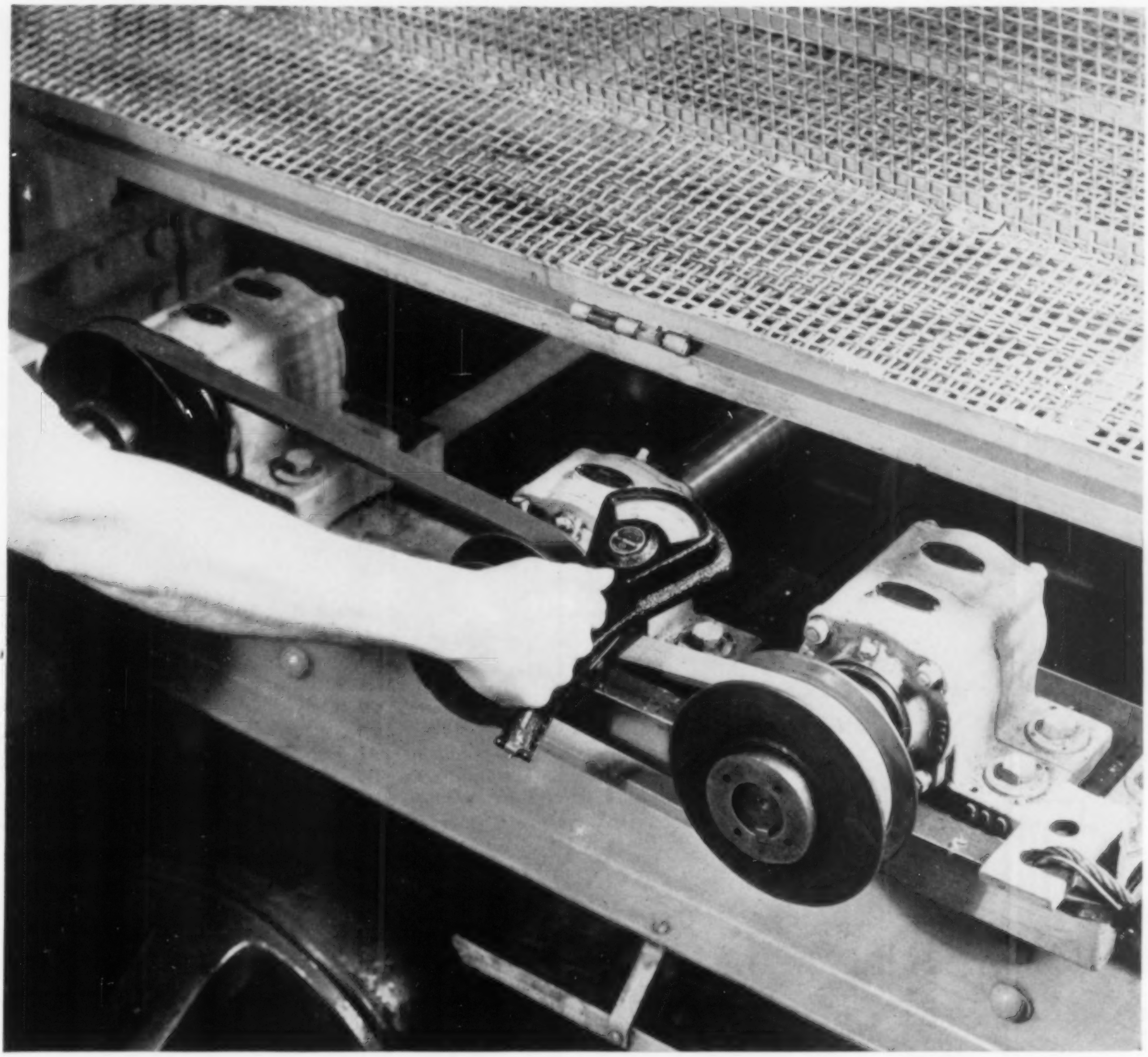
COOK'S PLAIN RING
COOKTITE SEALING RING
COOK'S WIPER RING

COOK'S GRAPHITIC IRON PISTON RINGS

lower the rate of cylinder wear, increase h.p. output per gallon of fuel and restore new engine power, even after cylinders are badly worn. These results are assured by the combination of (1) COOK'S GRAPHITIC IRON — the highly refined COOK'S Ring material; (2) exclusive designs that positively and permanently seal combustion pressures; (3) pre-conditioned wearing surfaces. You too can reduce your operating and maintenance costs by installing COOK'S Rings next time you make replacements. Ask for informative literature.

C. LEE COOK MANUFACTURING CO.
INCORPORATED
New York Cleveland · Los Angeles Baltimore · LOUISVILLE, KY. · Chicago Tulsa · New Orleans San Francisco

☆*Experience says* "IT PAYS TO USE COOK'S GRAPHITIC IRON PISTON RINGS"!



His thermometer says fever has passed, the patient will live—longer

A typical example of Goodrich improvement in rubber

HE'S "taking the temperature" of a V-Belt — the rubber-and-fabric belt that drives thousands of America's machines. But when a short belt like this whirls around its pulleys, terrific heat is generated. Internal heat destroys belts, and V-belts were breaking down, causing stoppage of machinery, costing too much to maintain.

Goodrich engineers went to work on this "belt fever." They made up new compound after compound of rubber, made each into a belt, ran it until it wore out, taking its temperature as carefully as though it were a hospital fever patient in a crisis.

Finally a compound was discovered that did carry off the heat as developed, and so did run cooler. After scores more experiments this was perfected — it operates 75% cooler than old rubber compounds. At once this new development was used in all Goodrich V-Belts — and immediately belt costs went down in thousands of plants, production shut-downs were reduced, new records for belt life began to be made.

This sort of research goes on constantly at Goodrich—125 engineers are engaged exclusively in making every Goodrich product better, longer lived, less expensive for you to use. To be certain you are getting all the benefits of this great program of improvement, you have only to specify *Goodrich* to your Distributor. The B. F. Goodrich Company, Mechanical Rubber Goods Division, Akron, Ohio.

B. F. Goodrich

First IN RUBBER

DEPENDABLE PNEUMATIC SERVICE

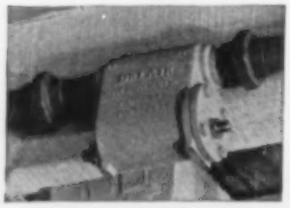
IN
OUT
DRIAIR
NEW JERSEY METER CO.
PLAINFIELD, N.J.
MADE IN U.S.A.

WHEN EQUIPMENT IS PROTECTED BY

DRIAIR

A COMPLETE SELF-CONTAINED UNIT

DriAir may be installed by suspending it from the piping without any other support.

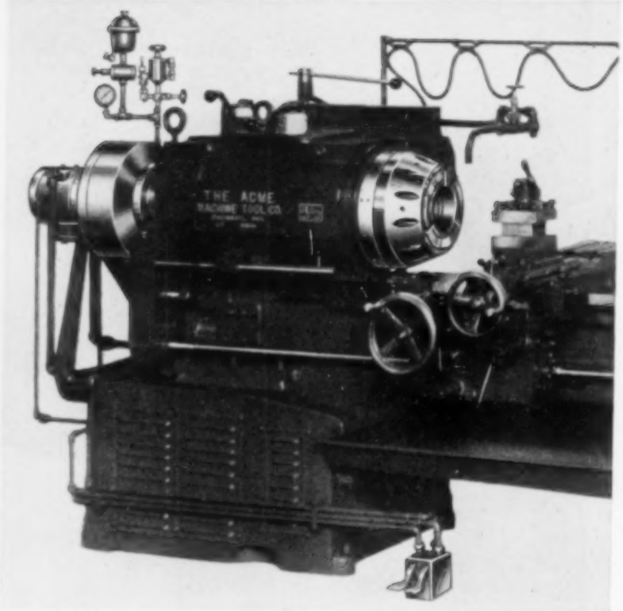


A typical installation showing DriAir standing on the floor next to the wall.

The answer to many problems which arise in various applications of compressed air, DriAir speeds production by separating and automatically ejecting the condensed water and oil from the air. DriAir collects dirt and rust from the air lines and delivers clean dry air to the tools, thus reducing wear and prolonging their life. All internal parts are made of bronze or copper—resistant to corrosion and practically permanent Copy of Bulletin DA fully describing the operation of DriAir sent on request; write today.

NEW JERSEY METER COMPANY
PLAINFIELD, NEW JERSEY

"LOGAN"



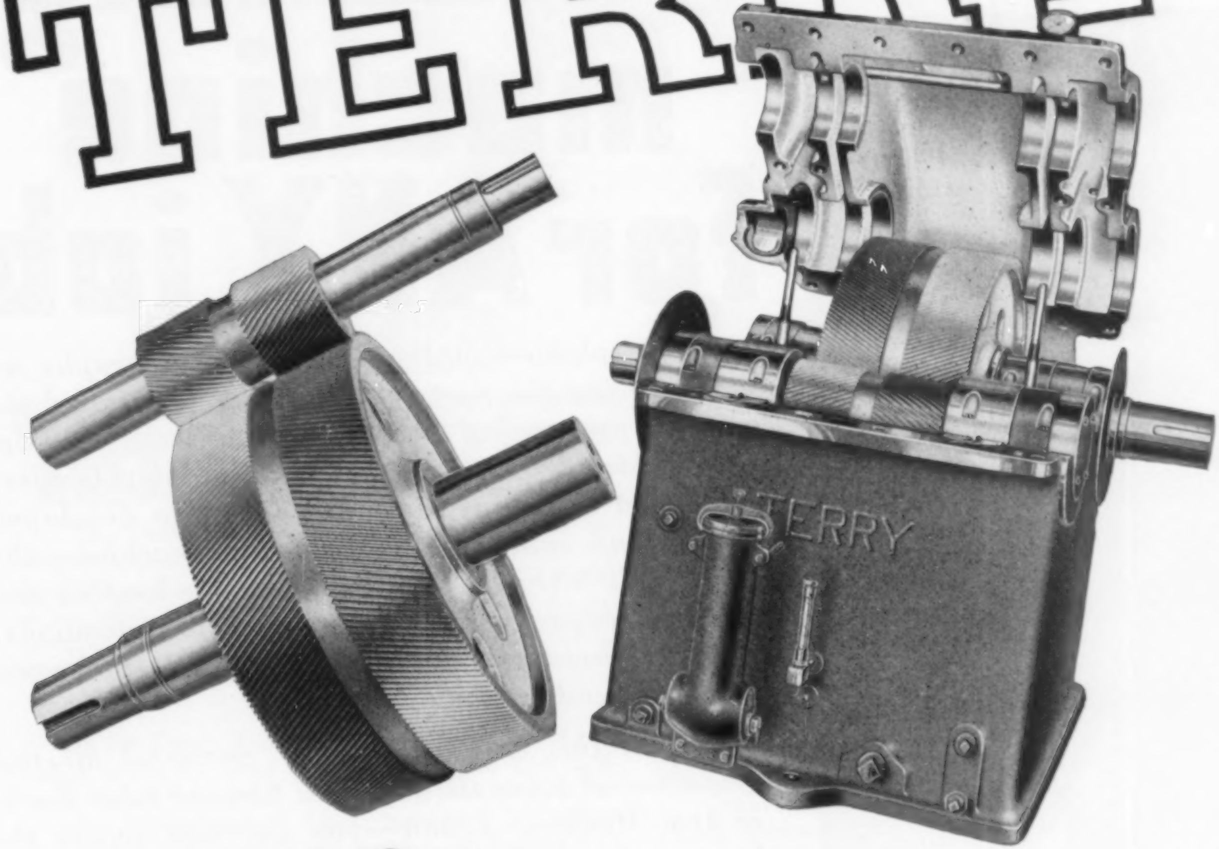
AIR EQUIPMENT AS USED ON ACME TURRET LATHE...

"LOGAN" ROTATING AIR CYLINDER
◆
"LOGAN" SPECIALLY DESIGNED AIR OPERATED COLLET CHUCK
◆
"LOGAN" AIR FOOT VALVE
◆
"LOGAN" LUBRICATION ASSEMBLY

This Cincinnati Acme Universal Turret Lathe is fitted with a 6 inch "LOGAN" Air Operated Collet Chuck and a rotating type Air Cylinder and accessories. The special feature of the machine is the headstock, which is provided with an enlarged deep throated spindle with a 15 inch flanged nose, to which the "LOGAN" Collet Chuck and Drawrod is fitted. This arrangement permits the handling of work pieces with minimum overhang and without outboard support. Capacity: Up to 6 inches diameter, with 22 inches from face of chuck to bottom of drawrod. Various types of work locators can be built into the spindle. This heavy duty "LOGAN" equipment assures rigid chucking in machining shells or similar forgings. "LOGAN" Representatives and "LOGAN" Engineers will be glad to make recommendations on your problems.

LOGANSPORT MACHINE, INCORPORATED
920 Payson Road LOGANSPORT, INDIANA
Manufacturers of Air and Hydraulic Devices, Chucks, Cylinders, Valves, Presses and Accessories

TERRY



GEARS —
FOR SPEED INCREASING
OR SPEED REDUCING

The Terry gear has been developed to handle the high speeds and powers that are associated with steam turbine installations. It has been used successfully in thousands of plants in connection with turbines, high speed centrifugal compressors and the like.

Each Terry gear is carefully engineered to suit the installation. All rotating parts are accurately balanced. Forced feed lubrication is used on the bearings and the meshing teeth. The teeth are double helical and are generated on precision gear cutting machines. The bearings are of the babbit lined sleeve type and are unusually heavy so as to prevent distortion under load.

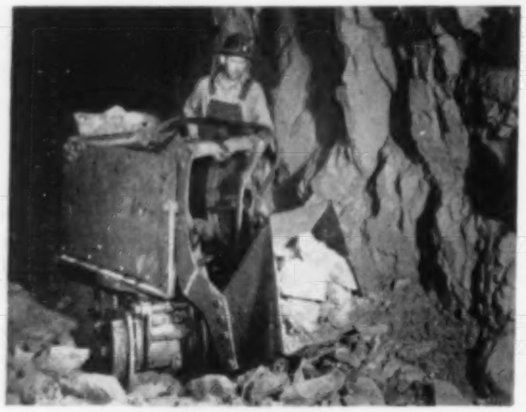
Full details of the Terry gear are included in our bulletin S-130. A request on your business letterhead will bring a copy.

Above: Typical Terry high speed gear. Accurate fixtures and gauges insure that the boring of the case is in perfect alignment and that standard bearing shells will exactly fit and be interchangeable.

T-1145

THE TERRY STEAM
TURBINE COMPANY
TERRY SQUARE, HARTFORD, CONN.

the BEST mucking machine for ANY job


Model 12-B

Model 21

As explained in the following paragraphs we have, during the past year, not only continued the ten-year program of constant research and development which has always kept Eimco-Finlay Loaders far ahead of competition, but have also developed a new and much larger mucking machine—the EIMCO TUNNELOADER—with ample loading and clean-up capacity to meet the heaviest demands; and with obvious ability to completely fill the largest cars used underground.

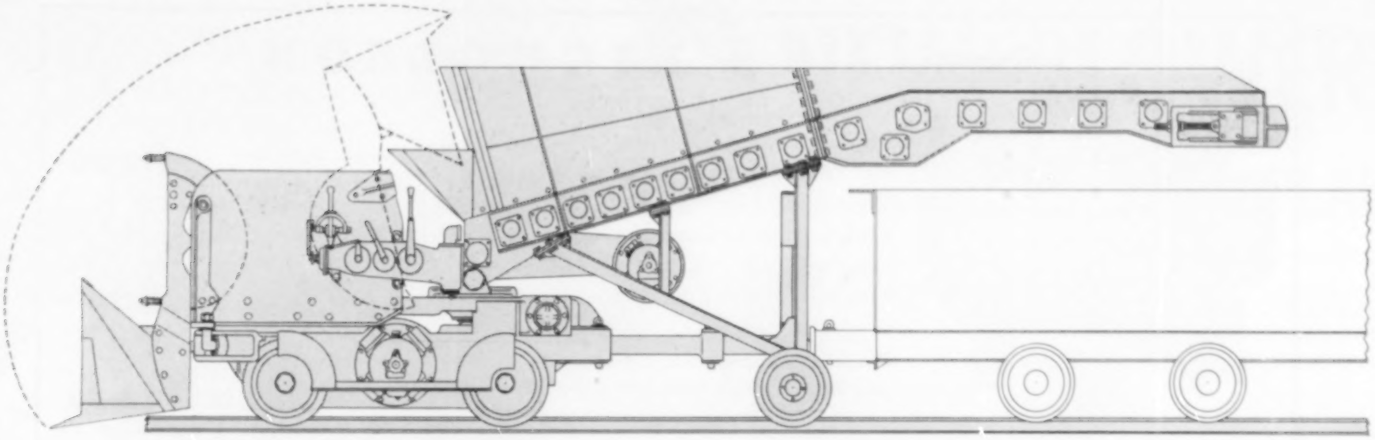
From this enlarged line of powerful all-steel loaders—all using the patented Eimco-Finlay Rocker-Arm Mucking Action—you can now secure the best mucking machine for ANY job, at lowest ultimate expense.

EIMCO-FINLAY LOADERS

Already out-performing any other mucking machines of comparable size and type the Model 12-B and Model 21 Eimco-Finlay Loaders have recently been raised to still greater heights of superiority by the introduction of a new high-torque, high-power, five-cylinder radial air motor, designed especially for this purpose by the Ingersoll-Rand Company and containing many improved features never before available. The combination of this new high-power motor with our patented, exclusive, rocker-arm mucking action, gives astonishing speed, power and flexibility. When digging into a muck pile both crowding force and digging thrust are so great that stalling is almost impossible. After the bucket has been filled the elevating acceleration is so rapid (if desired) that even larger cars can be filled than heretofore. Tramming speeds, in either direction, can also be made much faster.

The Model 12-B Eimco-Finlay Loader can be used effectively in drifts as small as 4'-6" wide by 6' high—loads cars up to 50 cu. ft. capacity at the rate of a ton per minute—uses less air than the average "drifter" drilling machine. Model 21, with wider clean-up, loads larger cars at the rate of two tons per minute. Either machine, if used to anywhere near capacity, will save its entire cost in less than 600 ft. of drifting and still be practically as good as new. Bulletin No. 105 (48 pages) gives complete information.

The EIMCO CORPORATION
SALT LAKE CITY, UTAH, U.S.A.
NEW YORK, 120 Broadway
SACRAMENTO, 1217 7th St.
CHICAGO, 111 W. Washington Ave.
EL PASO, Mills Building



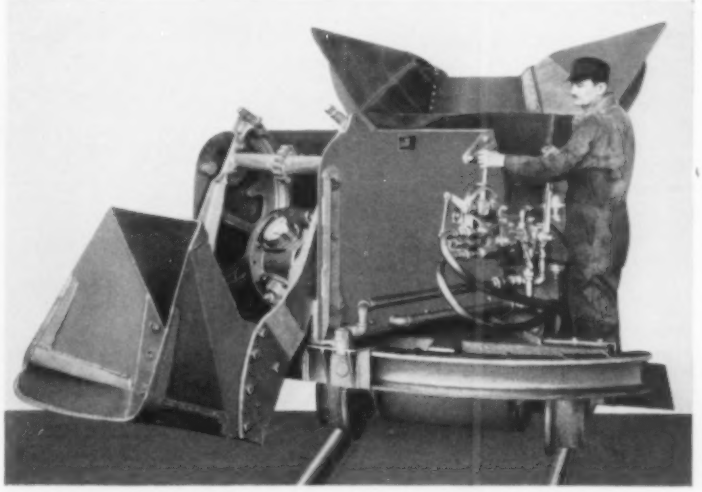
THE EIMCO

MODEL 40 Tunneloader

The unequalled efficiency and economy of our Eimco-Finlay Mine-Car Loaders have naturally brought many requests from tunnel contractors for a mucking machine operating on the same fundamental principle, but having greater digging capacity, wider clean-up and ability to fill longer cars.

In the Eimco Tunneloader we now offer a machine which not only meets all of these specifications 100%, but also affords the additional important advantage of being powered by either compressed air or electric motors as desired. In either case its operation is almost unbelievably efficient—crowding the 12 cu. ft. bucket deep into any muck pile by its enormous self-tramming power—rolling the heaviest bucket load easily and swiftly over into its dumping position—pouring such a stream of muck off the end of its 28" conveyor that the largest cars are filled completely full at the rate of more than three tons per minute.

Besides being much larger and more powerful than any of our previous loading machines, it is equipped with a separately-powered self-locking worm-and-gear mechanism for swinging the bucket assembly to any desired digging position without manual effort by the operator. Another improved feature is the large hopper into which the bucket discharges direct from any digging position, and from which the muck is continually carried away by the belt conveyor.



Other important operating advantages include sectionalized construction, which permits traveling around relatively sharp curves—easy disassembling for transportation or caging—surprisingly moderate head-room requirements, and very low expense for both operation and maintenance. Write for bulletin 106 or use the convenient coupon below.

OUR GUARANTEE

Year after year, far more Eimco-Finlay Loaders are manufactured and sold than all competitive types combined, and their inherent superiority has been so thoroughly established that every Model 12-B or Model 21 machine is sold with a positive, money-back guarantee that it will outlast and outperform any other mucking machine on the market of comparable size and type, at any air pressure and under any working conditions.

We now guarantee the Eimco Tunneloader to outperform ANY other type of underground mucking machine—regardless of size or price.

FOREIGN AGENTS

INGERSOLL-RAND CO., LTD.
165 Queen Victoria St., London, Eng.
* **BRITISH MIN. SUP. CO. (PTY.), LTD.**
Troye House, Johannesburg, S. A.
* **HODGSON & CRANSTON**
Boulder Road, Kalgoorlie, Australia
CLYDE ENGINEERING LTD.
Wellington, New Zealand

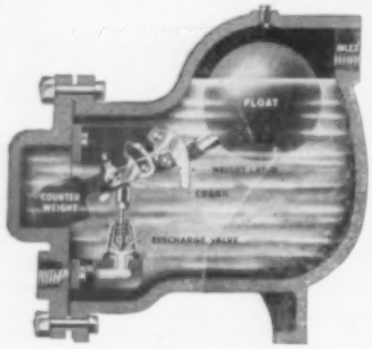
* **MINE EQUIPMENT COMPANY LTD.**
Kirkland Lake, Ontario, Canada
* **B. C. EQUIPMENT CO., LTD.**
551 Howe St., Vancouver, B. C.
* **MARSMAN TRADING CORPORATION**
Manila and Baguio, Philippine Is.
INTERNATIONAL MACHINERY CO.
Rio de Janeiro, Santiago and Antofagasta

* *Replacement parts carried in stock by agents indicated with asterisks.*

THE EIMCO CORPORATION, Salt Lake City, Utah, U. S. A.
Gentlemen:
Without charge or obligation, please send me—
☐ Bulletin 105, describing the Eimco-Finlay Loader.
☐ Bulletin 106, describing the Eimco Tunneloader.

Name ....
Position or title ....
Company ....
Address ....

"NICHOLSON"



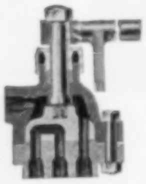
Model JR

COMPRESSED AIR TRAPS for automatically draining water and oil from Air Tanks, Receivers, Aftercoolers, Separators, etc. Valve always water sealed. Quick snap action—Made in one body size with ½", ¾" or 1" inlet and ½" outlet—Good for pressures up to 125 lbs.

OTHER PRODUCTS: Air Separators, Steam Traps, Flexible Couplings, Expanding Mandrels, Steel and Stainless Steel Floats, etc.

Bulletin No. 341 on request.

AIR CONTROL VALVES: 2, 3, or 4-way, flat disc type for single and double acting air, steam, water or oil cylinders, etc. Non-corrosive metals used in all vital parts. Sizes ¼" to 1½".



W. H. NICHOLSON & CO.
165 Oregon St. Wilkes-Barre, Pa.

FOR THE MOST CRITICAL SILENCING PROBLEMS

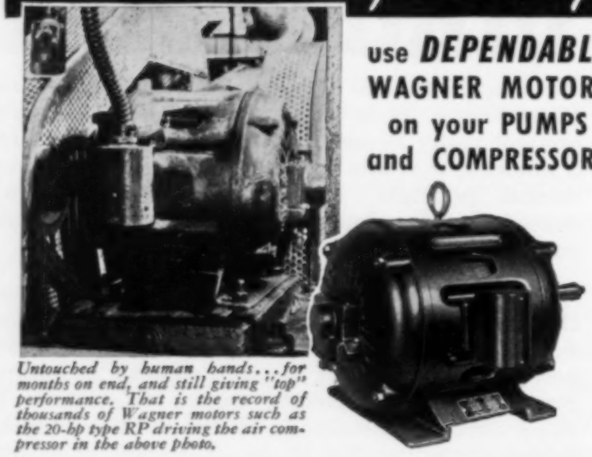
A power plant operating 24 hours a day on an island . . . that's a place where you need "whisper quiet" silencing. Maxim MU2 Silencers were chosen for this plant on Fishers Island, New York, and even close neighbors can't notice any exhaust noise.

Maxim can solve your silencing problems. Write for details.

THE MAXIM SILENCER CO.
85 Homestead Ave. Hartford, Conn.

Shut-Downs Caused by Motor Failure *Cost You Money!*

use *DEPENDABLE* WAGNER MOTORS on your PUMPS and COMPRESSORS



Untouched by human hands . . . for months on end, and still giving "top" performance. That is the record of thousands of Wagner motors such as the 20-hp type RP driving the air compressor in the above photo.

Safeguard your plant against excessive motor maintenance and lost production time by selecting motors that have a reputation for dependability and efficiency. Because Wagner motors are varied mechanically to meet all operating conditions, and varied electrically to meet the requirements of different types of equipment, they are ideal for use in operating all types of pumps and compressors. . . . Whether buying new equipment or replacing motors on equipment you have, it will pay you to specify Wagner. . . . Get the facts—write for bulletins MU-177 and MU-182.

M41-12

Wagner Electric Corporation
6400 Plymouth Avenue, Saint Louis, Mo., U.S.A.
MOTORS • TRANSFORMERS • FANS • BRAKES

NEW YORK OFFICE
60 EAST 42ND STREET

MAIN OFFICE
AND WORKS
BUFFALO, N.Y.

GEORGE H. CHISHOLM
PRESIDENT
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VICE PRES & GEN MGR.
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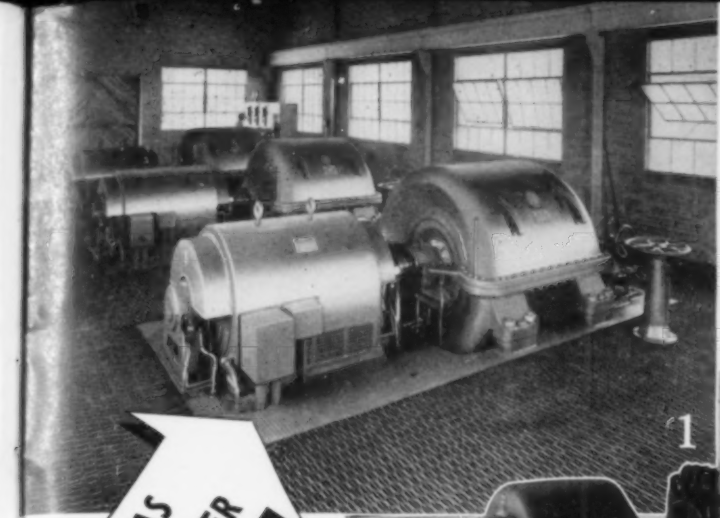
CLINTON R. WYCKOFF
TREASURER

ATLAS STEEL CASTING COMPANY

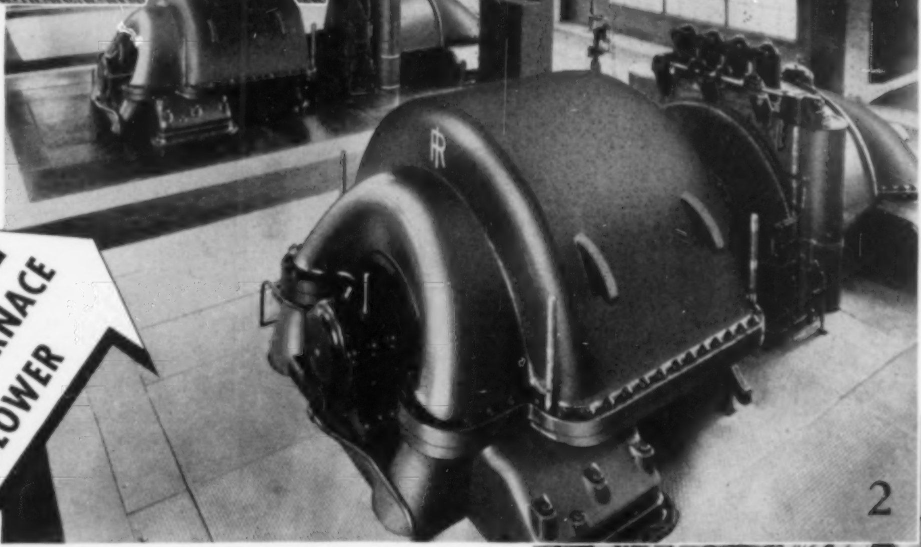
OPEN HEARTH & ELECTRIC STEEL
1963 ELMWOOD AVENUE
BUFFALO, N.Y.

8 NEW BLOWERS

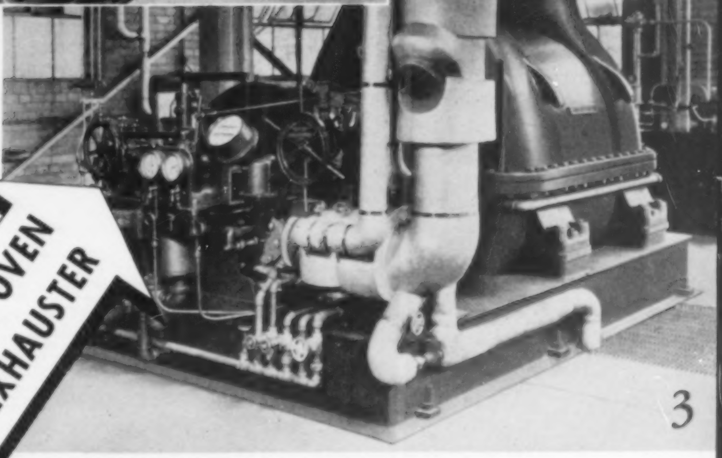
IN THIS MODERN STEEL PLANT



1 *The 850-hp gas boosters each handle 27,000 cfm of producer gas.*



2 *Each of these Ingersoll-Rand blast furnace blowers delivers 60,000 cfm at 30 lbs. pressure.*



3 *One of the three multi-stage turbine-driven blast furnace blowers used in exhausting coke ovens.*

The Great Lakes Steel Co., in modernizing its Detroit, Mich. plant, chose 8 Ingersoll-Rand turbo blowers for blast furnaces, coke plant and gas distribution.

Practically every steel producer in the U. S. A. is using Ingersoll-Rand turbo blowers for handling air or gas. Included in the I-R line are blowers from 2 to 14,500 hp. There are turbine-driven blast furnace blowers, motor or turbine-driven gas boosters, coke-oven exhausters, motor-driven combustion-air blowers, and auto-dynamic gas mixers.

There is an experienced I-R representative in every steel center—ask his help in solving your blower problems.

Ingersoll-Rand

11 BROADWAY, NEW YORK CITY

Branches or Distributors in other Principal cities the world over

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Birmingham
Boston
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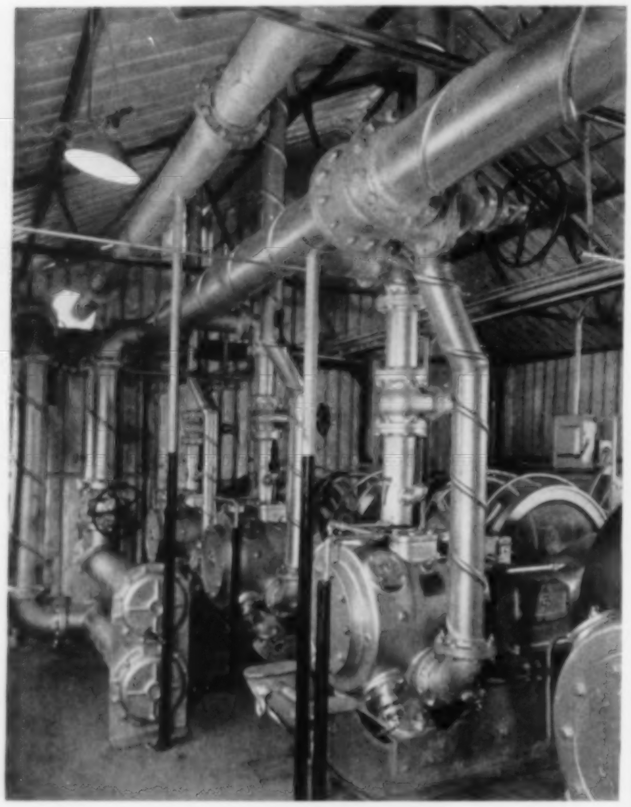
London Paris Madrid Lisbon Melbourne Calcutta Johannesburg

12-45

•TODAY'S HEADQUARTERS

For Light-Weight Pipe



● To help you avoid possible costly delays in obtaining light-weight pipe, Naylor has stepped up production to provide a dependable source of supply in today's complex market.

Naylor's exclusive Lockseam Spiralweld assures a light-weight pipe for high or low-pressure service with greater strength, safety and savings.

Sizes from 4″ to 30″ in diameter. All types of fittings and connections. Complete fabrication service.

Write for Catalog or Send Specifications for Quotation.

NAYLOR PIPE COMPANY
1245 EAST NINETY-SECOND STREET
CHICAGO, ILLINOIS

NAYLOR LOCKSEAM SPIRALWELD PIPE

DUAL PROTECTION

The WILLSON Bantam is the lightest weight throw-away filter type respirator ever to receive U. S. Bureau of Mines approval.

Guard against tie-ups. Insist on the Dual Protection of WILLSON Safety Equipment. WILLSON has the right goggle or respirator for every conceivable industrial hazard . . . especially designed to provide maximum protection with full comfort to the wearer. Both are important. See your local WILLSON Safety Service Representative or write direct for complete information.

GOGGLES . GAS MASKS
RESPIRATORS . HELMETS

WILLSON
PRODUCTS INCORPORATED
READING, PA., U.S.A. *Established 1870*

MORE WORK *with* LESS EFFORT

The lighter weight of Ingersoll-Rand Modern Air Tools reduces operator fatigue. Their power and flexibility also help get jobs done quicker and better.

Use
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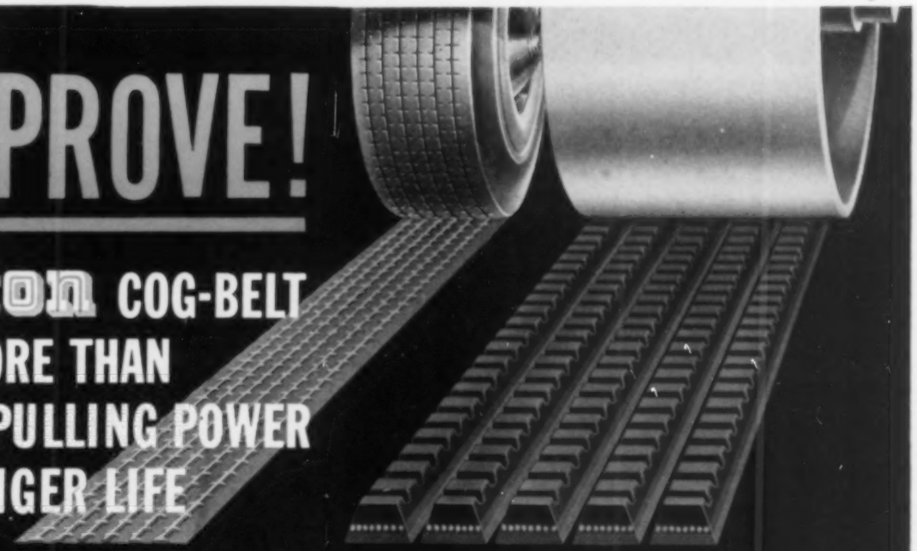
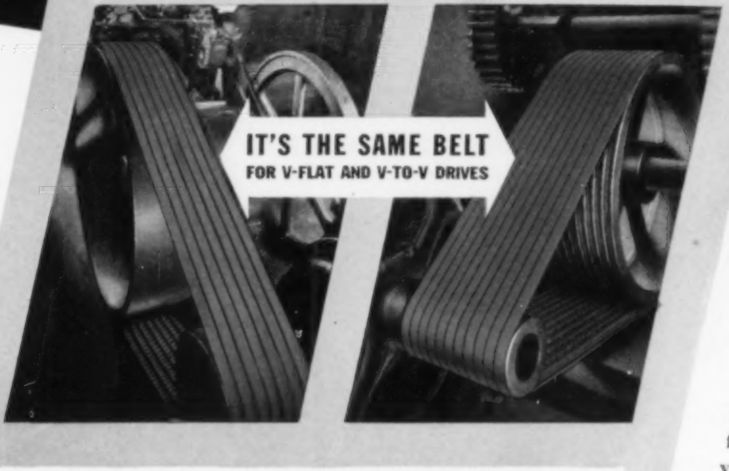
AIR TOOLS
Size 57 "Multi-Vane" Grinder
Size 88 "Multi-Vane" Grinder
Size 5GW "Multi-Vane" Grinder
Size 4G "Multi-Vane" Grinder
943-3

Ingersoll-Rand
11 Broadway, New York, N. Y.

TESTS PROVE!

NEW Dayton COG-BELT HAS MORE THAN 21% GREATER PULLING POWER 22% LONGER LIFE



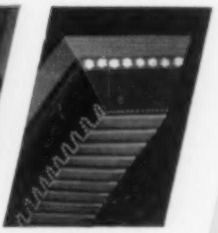


IT'S THE SAME BELT
FOR V-FLAT AND V-TO-V DRIVES

ONLY BELT EVER BUILT ON TIRE TREAD PRINCIPLE OFFERS *EXTRA VALUE* AT NO ADDITIONAL COST

BUILT-TO-BEND FEATURE AND DAYTEX CORD mean longer life under constant high-speed flexing.

FLAT COGS AND DIE-CUT SIDES provide greater gripping power on grooved pulleys and on flat pulleys.



CROSSWISE RIGIDITY prevents distortion—assures maximum efficiency and longer belt life.

Combining a new flat cog design with Dayton's famed raw edge feature, Dayton technicians have developed this outstanding achievement—the same belt for either flat pulleys or grooved pulleys—an extra value belt that sets new records for pulling power and long life.

This new cog-belt is the only belt built on the scientific principle of increasing traction by means of a non-skid design. In test after test, in hundreds of field applications, this new belt made on the tire tread principle gave at least 21% more pulling power than other belts tested.

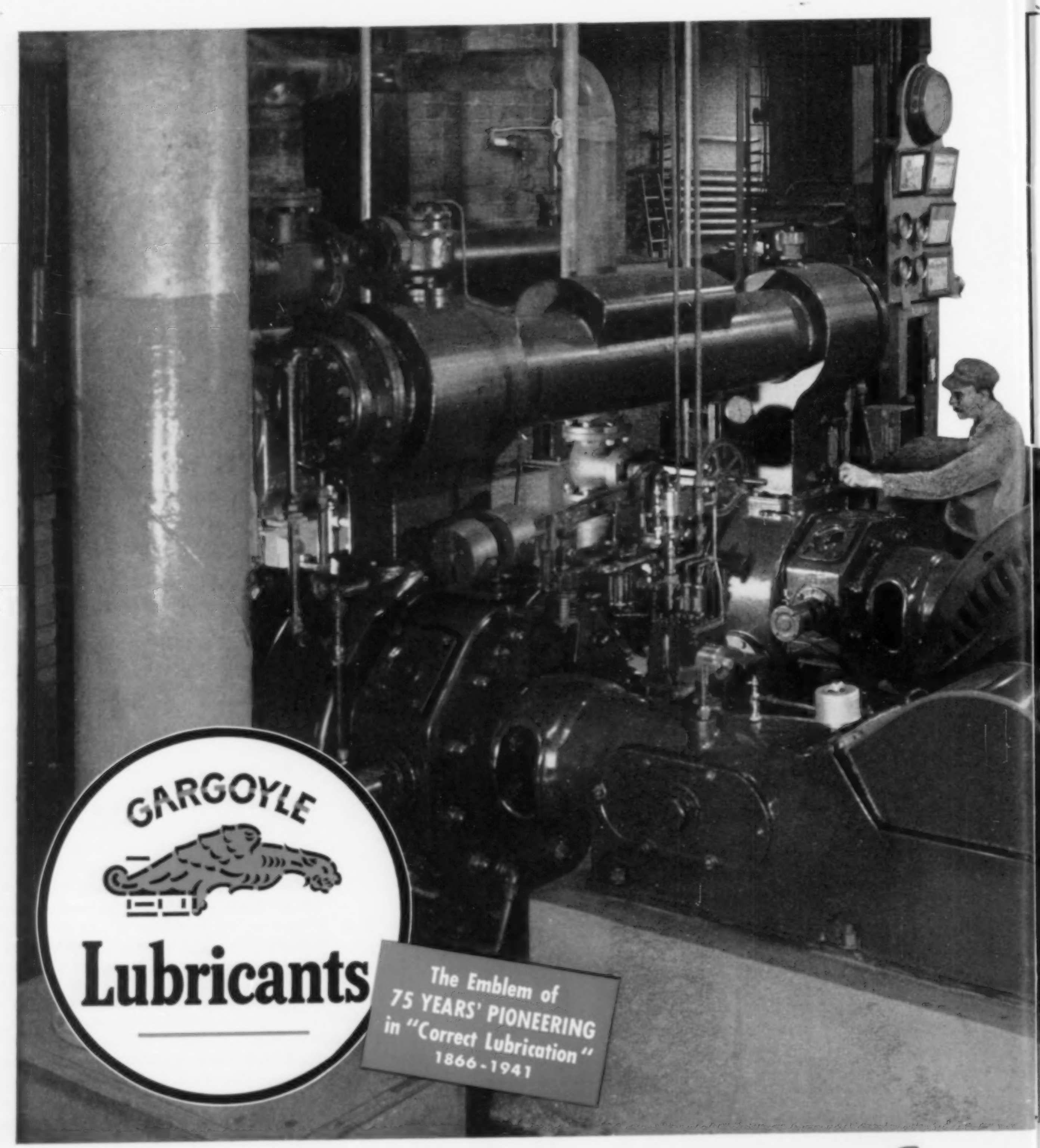
More than that, with its Built-to-Bend construction and exclusive Heat-Resistant Daytex Cord, Dayton Cog-Belts are cooler running and stand up longer under the strain of constant high-speed flexing. They have proved themselves to give an overall longer life of at least 22 per cent.

To meet the sky-rocketing demand for its products, the great Dayton factory—utilizing to the fullest extent the skill and "know how" gained in 36 years of manufacturing experience—is straining every resource—24 hours a day—to provide American industry with the greatest possible volume of Dayton Cog-Belts.

THE NEW Dayton COG-BELT WITH UNIVERSAL DRIVING SURFACE

Copyright 1941, The Dayton Rubber Mfg. Co.

The Dayton Rubber
MANUFACTURING CO. DAYTON, OHIO
The World's Largest Manufacturer of V-Belts
DAYTON, THE GREATEST NAME IN V-BELTS

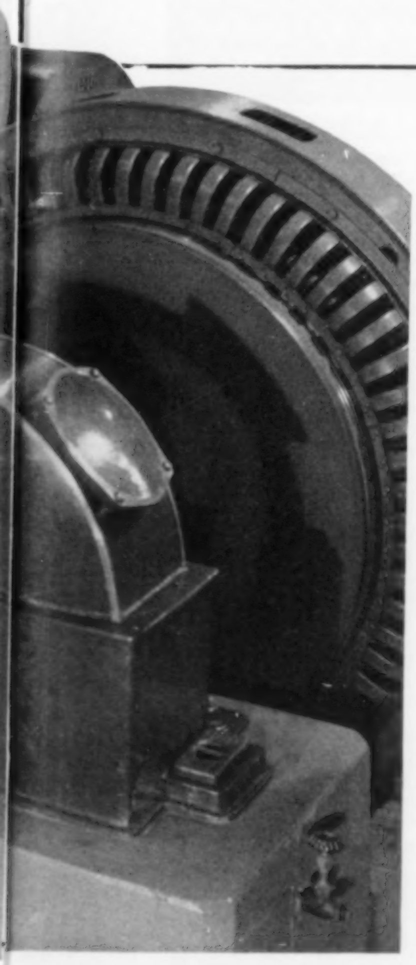

GARGOYLE
Lubricants
The Emblem of
75 YEARS' PIONEERING
in "Correct Lubrication"
1866-1941

CALL IN **Socony-Vacuum for**

YOU'LL BENEFIT FROM: 75 YEARS' LUBRICATION EXPERIENCE •
PRODUCTS APPROVED BY ENGINE BUILDERS •

GARGOYLE D.T.E. OILS HELP YOUR VALVES

Shut Tight!



GARGOYLE D.T.E. OILS are especially suited for efficient valve lubrication. They have the two qualities needed for the job—great stability and high natural lubricity.

Because of Gargoyle D. T. E.s' great stability, you needn't worry about carbon deposits on your discharge valves. These oils help valves function efficiently and seat tightly.

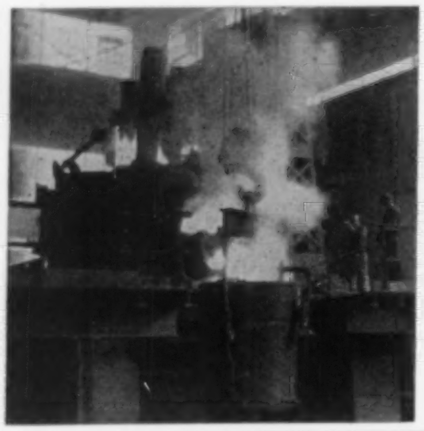
The high natural lubricity of Gargoyle D.T.E.'s permits small feeds. That means minimum oil consumption... safe operation.

You benefit with high compressor efficiency ...operation at maximum capacity.

"Correct Lubrication"

THE RIGHT OIL FOR EACH JOB • NEW LUBRICANTS AHEAD OF NEW NEEDS •

SOCONY-VACUUM OIL COMPANY, INC. • Standard Oil of New York Div. • White Star Div. • Lubrite Div. • Chicago Div. • White Eagle Div. • Wadhams Div. • Southeastern Div. (Baltimore) • Magnolia Petroleum Co. • General Petroleum Corp. of Calif.



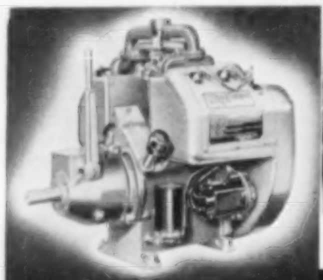
Control

—right from the start for—

BASIC ELECTRIC STEEL FORGINGS

COMPLETE control of all processing from selection of the melting charge to the finished condition is the N. F. & O. *guarantee of quality* in forgings furnished to your specifications–Smooth Forged, Hollow Bored, Rough or Finished Machined.

NATIONAL FORGE & ORDNANCE CO.
IRVINE, WARREN COUNTY, PENNA. U. S. A.



Wisconsin-powered Compressors

Built-in **POWER** TO FIT THE MACHINE AND THE JOB!

Illustrated is the sensational 4-cylinder **Model VE-4** 22 hp. engine. Weight, standard engine: 285 lbs.

Today, more than 300 manufacturers, in many industries, use Wisconsin heavy duty air-cooled engines either as built-in primary power or auxiliary power for their equipment.

Here is extreme compactness; light weight; air-cooled freedom from "weather grief"; economical operation . . . dependable power to fit *your* kind of equipment and *your* kind of work. Detailed data on request.

MOST POWER PER POUND
HEAVY-DUTY AIR-COOLED ENGINES
by **WISCONSIN MOTOR CORPORATION**
Milwaukee, Wisconsin, U. S. A.

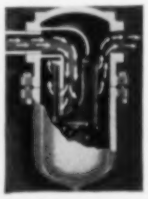
World's Largest Builders of Heavy-Duty Air-Cooled Engines

Removes 99% plus of water, dirt and oil from compressed air

THE unusual efficiency of the Johnson-Gast Separator arises from the fact that it combines, in one simple device, the two most effective principles of separation—expansion and change of direction. As the air enters it is allowed to expand, precipitating most of the moisture. Then it passes through the "thousand baffles"—a labyrinth of coarse wire mesh—changing direction of flow many times and surrendering particles of water and dirt at every turn.

In all Johnson-Gast Separating Devices you'll find this same combination of simple design and high efficiency. The After-cooler is frequently installed ahead of the separator to condense all moisture vaporized by heat of the compressor. A typical installation is pictured here. The Oil Absorber is used for services where every final trace of oil must be removed, as in paint spraying.

Write for new bulletin



FOR USE ON STEAM LINES TOO

THE JOHNSON CORPORATION
830 Wood Street, Three Rivers, Michigan

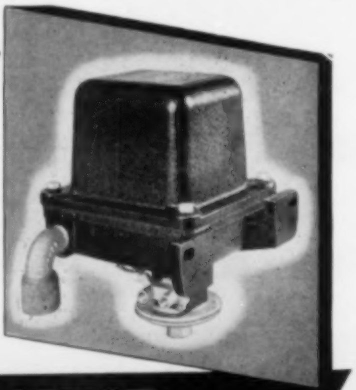
JOHNSON-GAST
SEPARATORS • AFTERCOOLERS • OIL ABSORBERS

HERE IS AN *Explosion-Resisting* PRESSURE SWITCH

● The **CLASS 9013 TYPE AR** switch is built for use in Class I Group D hazardous locations. Top pressure 225 lbs.—standard air compressor settings—with or without release valve. Ratings are 2 H.P. 110 V., 3 H.P. 220 V. single phase and 5 H.P. 220-550 V. polyphase.

SWITCH • PROTECT • REGULATE • DO IT ALL WITH SQUARE D

SQUARE D COMPANY • REGULATOR DIVISION • DETROIT



COMPRESSOR
EQUIPMENT
STURDY * SOUNDLY DESIGNED

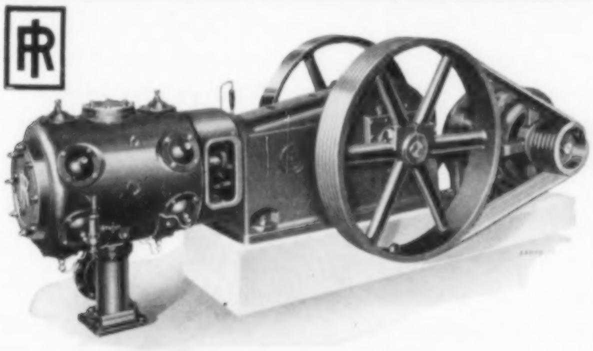
JARECKI VALVES
Sizes and types to meet every condition, each soundly built, perfectly threaded and individually tested.

ERIE UNLOADER
Maintains constant pressure by governing inlet of compressor. Loads and unloads without shock or strain.

ERIE GOVERNORS
For steam engines, pumps or compressors. For speed control only or for combined speed and pressure control.

JARECKI FITTINGS
Air-furnace malleable fittings . . . close-grained, cast iron fittings, all with perfect threads. A complete line.

JARECKI Manufacturing Co.
ERIE PENNSYLVANIA, U.S.A



CLASS *ES* COMPRESSOR
A STAR PERFORMER —IN ANY PLANT!

If your conditions require continuous, full-load operation the I-R class ES Compressor is the machine you need. It is widely known as the most efficient single-stage compressor available in the 5-125 hp range. Furnished for any type of drive. Cylinders available for handling air or gas, for a wide range of pressures and for vacuum services.

Write today for form 3063-A which gives complete details.

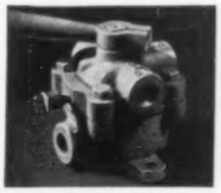
873-1

Ingersoll-Rand
11 BROADWAY, NEW YORK CITY

A *Timely* NEW BULLETIN *for Users of* Air *and* Hydraulic Power

Production executives, maintenance men, plant engineers . . . this new bulletin will prove mighty helpful to you, now, when you're striving to make production keep pace with demand.

Its detailed drawings, concise descriptions and complete mechanical data on the entire line of NOPAK Cylinders can help you make the most effective use of Air and Hydraulic power in a wide variety of applications throughout your plant. Incidentally, it brings you up to date on recent NOPAK developments in cylinder design and performance.



NOPAK VALVES
2-, 3- and 4-way, result in precision control of air or hydraulic equipment. They're at their best when teamed up with NOPAK Cylinders.

Your request for Bulletin 82 on your company stationery will receive our immediate attention.

GALLAND-HENNING
MFG. COMPANY
2759 SOUTH 31st STREET
MILWAUKEE, WISCONSIN

Representatives in Principal Cities

NOPAK VALVES and CYLINDERS
DESIGNED for AIR or HYDRAULIC SERVICE

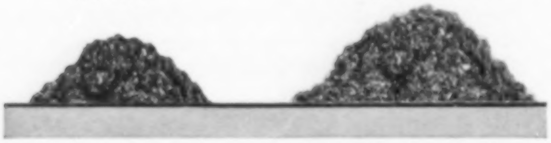
A3502-½

Now–
the sparks
are flying
–TWICE AS FAST!

A practical, unbiased Rotor Analyst on the job, showing how a modern, Rotor Air tool doubles production.

METAL REMOVED FORMERLY
40 to 50 oz. per hr. with air tools

METAL REMOVED NOW
80 to 90 oz. per hr. with Rotor air tools



Tools were heavy and slow! The air tools used by this manufacturer of valves and pipe fittings were several years old. They weighed 15 lbs.! (A modern Rotor of equal capacity weighs only 9¾ lbs.) Tools were operating at 3400 R.P.M. with vitrified wheels. There was plenty of air to provide 85 lbs. pressure at the tools.

Changed wheels. I suggested use of modern Rotor "Powerplus" Air Grinders with high-speed bonded wheels instead of the vitrified wheels. Boosted speed to 6000 R.P.M. which was O.K. with the Safety Code.

Doubled production. Brought in a trial grinder. Took off my coat and showed them how this high-speed, light-weight tool makes the sparks fly. (Photo shows me hard at it.) Boosted metal removal from 40-50 oz. per hour to 80-90 oz. per hour—about twice as much.

They've changed over entirely to Rotor "Powerplus" Air Grinders.

Air or High-Cycle? I'd be pleased to give you practical help to study your portable tool operations and develop *faster production* and *lower costs.* I can bring in tools, gauges and all necessary equipment to demonstrate either Air or High-Cycle tools. I'm practical and I'm unbiased.

—THE ROTOR ANALYST

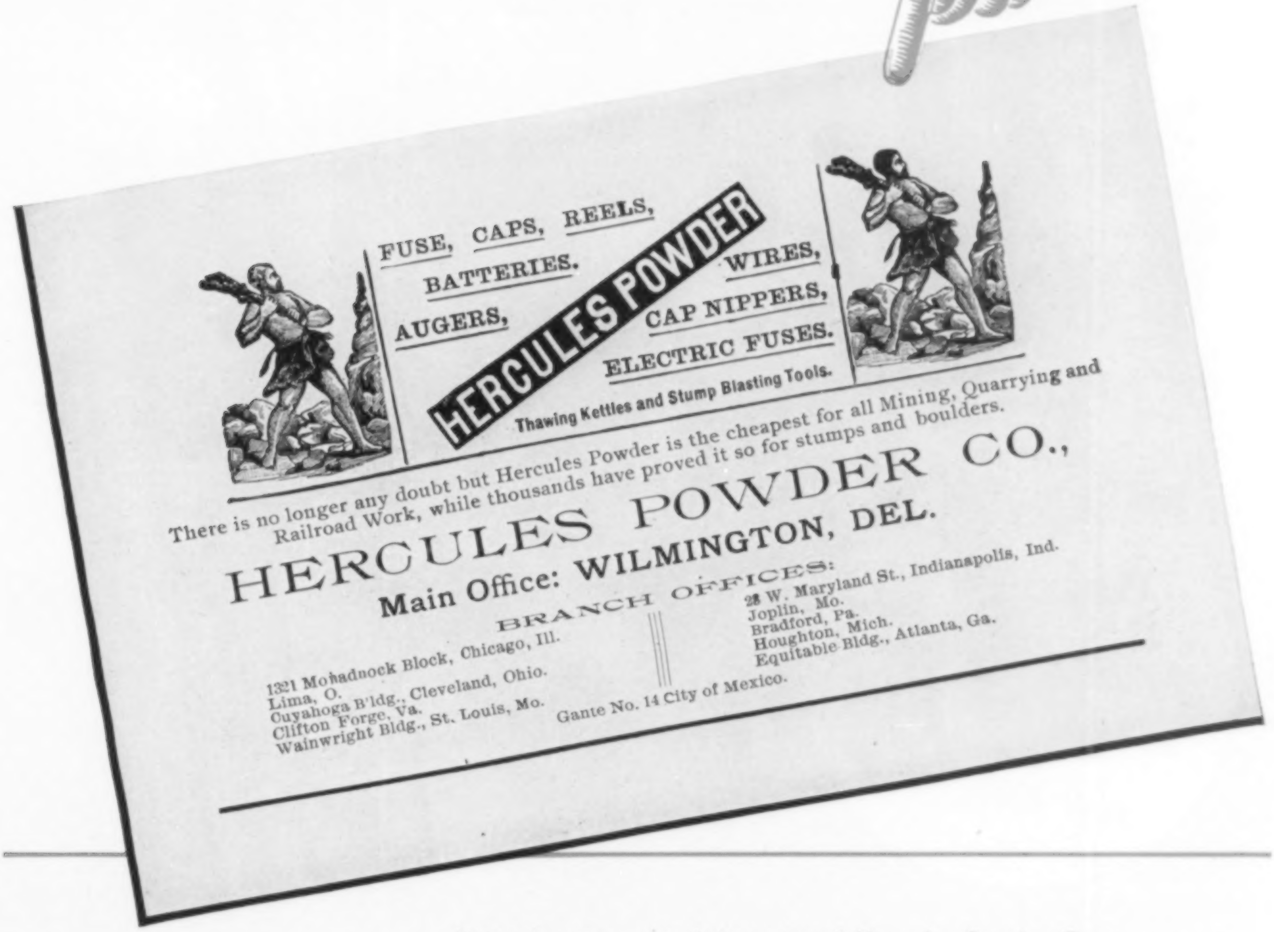
The Rotor Analyst has 65 different Air tools and 59 different High-Cycle tools with which to solve your problems.

AIR

THE ROTOR TOOL CO.
CLEVELAND, OHIO
UNBIASED ANALYSIS OF PORTABLE TOOL PROBLEMS

HIGH CYCLE

45 YEARS AGO . . .



FUSE, CAPS, REELS,
BATTERIES.
AUGERS,
HERCULES POWDER
WIRES,
CAP NIPPERS,
ELECTRIC FUSES.
Thawing Kettles and Stump Blasting Tools.

There is no longer any doubt but Hercules Powder is the cheapest for all Mining, Quarrying and Railroad Work, while thousands have proved it so for stumps and boulders.

HERCULES POWDER CO.,
Main Office: WILMINGTON, DEL.

BRANCH OFFICES:

1321 Mohadnock Block, Chicago, Ill.
Lima, O.
Cuyahoga B'ldg., Cleveland, Ohio.
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Gante No. 14 City of Mexico.
28 W. Maryland St., Indianapolis, Ind.
Joplin, Mo.
Bradford, Pa.
Houghton, Mich.
Equitable Bldg., Atlanta, Ga.

This advertisement of the original Hercules Powder Company appeared in the December, 1895, issue of a magazine called "Stone." The economy of Hercules Explosives for mining, quarrying, and construction, which was beyond doubt then, is even more widely recognized today.

HERCULES POWDER COMPANY
INCORPORATED
WILMINGTON • DELAWARE

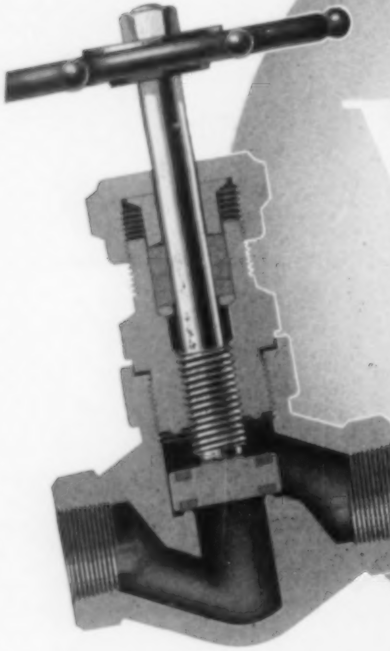
A-82

DROP FORGED STEEL AND SEMI-STEEL VALVES FOR ICE MAKING AND REFRIGERATING PLANTS!

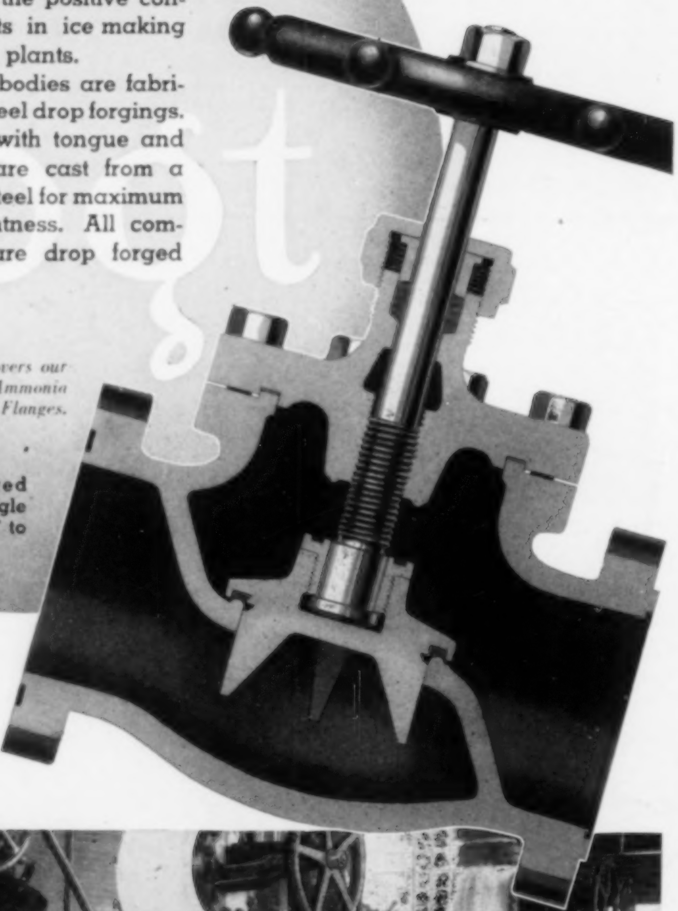
Vogt builds a complete line of ammonia valves for the positive control of refrigerants in ice making and refrigerating plants.

Screw end valve bodies are fabricated from solid steel drop forgings. Flanged bodies, with tongue and groove facings, are cast from a high grade semi-steel for maximum strength and tightness. All companion flanges are drop forged steel.

Catalogue 4F-2 covers our complete line of Ammonia Valves, Fittings and Flanges.



(*Above*) Screw End Globe and Angle Valves from 1/4" to 2" inclusive.



(*Right*) Flanged Globe and Angle Valves from 1/4" to 10" inclusive.

Vogt

AMMONIA VALVES

DROP FORGED STEEL

and

SEMI-STEEL TYPES

Vogt
FOR BETTER VALVES

VOGT REFRIGERATION PRODUCTS
include
Complete Compression and Absorption Ice Making and Refrigerating Plants – Ammonia Condensers – Brine Coolers – Ice Can Dumpers and Fillers – Water Tube and Tubular Boilers – Ammonia Valves, Fittings and Flanges.

HENRY VOGT MACHINE CO., Inc., LOUISVILLE, KY. *New York - Philadelphia - Cleveland Cincinnati - St. Louis - Chicago - Dallas*

THE 7 SEAS...
THE 7 CONTINENTS...
SPEAK THE JOHN CRANE PACKING LANGUAGE

★ ★ ★ Crane-fame girdles the globe! . . . . . From Zanesville to Zanzibar — in man-o'-war and tramp steamer, in commercial empire and hobby shop — wherever the subject of fine packings comes up, John Crane is the packing language every qualified engineer will speak. Yes, many's the plane that's flown an armful of John Crane to a stranded engineer who'd take no chances on anything else. It all adds up to one reason: superlative quality! . . . . . 302 packing styles and a 25-year-experience-file will lick any leak — anywhere. We have proven it thousands of times.

(Illustrated)

JOHN CRANE STYLE 4-AM . . . NEW SUPER-SEAL PLASTIC PACKING

Equipment: Steel valve stems and expansion joints.

Service: Superheated steam, temperatures to 1000° F. . . . High Pressures.

Specifications: Manufactured by braiding a jacket of pure asbestos yarn (Monel wire insertion) over resilient, white, non-metallic Super-Seal plastic. Jacket is securely vulcanized to plastic; impregnated with mica.

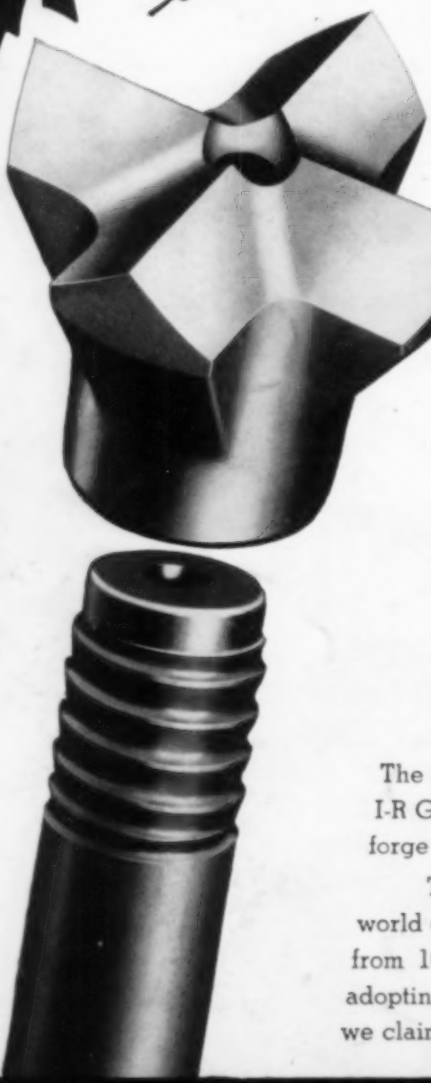
. . . There is a Super-Seal plastic Style for every packing requirement: industrial, marine, petroleum, chemical.

. . . Send for sample, mentioning your operation conditions . . . Super-Seal—designed for peak-load demands.

JOHN CRANE *Packings*

CRANE PACKING COMPANY, CHICAGO, U.S.A.
CRANE PACKING COMPANY, LTD., HAMILTON, ONT., CAN.

Dear Bill
The job is now running ahead
of schedule thanks to your suggestion
about Jackbits. They have not only
speeded up the work but they have
lowered my drilling costs 23%



Reasons why JACKBITS reduce drilling costs

- Smaller gauge sizes can be used. This greatly increases the drilling speed. On one large tunnel job the drilling time dropped from 16.4 to 13.5 minutes per foot of heading advance when Jackbits were put to work.
- They can be reconditioned very cheaply. Costs as low as 2.2c per bit have been reached.
- They result in the use of sharp bits a greater percentage of the time. Rock drill upkeep costs are thereby reduced.
- Air consumption per foot of hole drilled is less.
- The cost of drill steel transportation is practically eliminated.
- Jackbits reduce the amount of drill steel purchased annually.

The I-R Jackbit line is complete. You can resharpen your Jackbits on an I-R Grinder or Hotmill. You can heat-treat them in I-R Furnaces. You can forge the threads and shanks in I-R Sharpeners. Ask for Catalogue 2579.

The experiences of contractors, mining men, and quarrymen the world over show that the savings gained from the use of Jackbits range from 10 to 40%. One mine, quarry and contractor after another is adopting Jackbits. This would not happen if they were not doing what we claim for them.

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